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Compressed Air Magazine

Vol. XXXIII, No. XI London New York Paris 35 Cents a Copy

NOVEMBER, 1928

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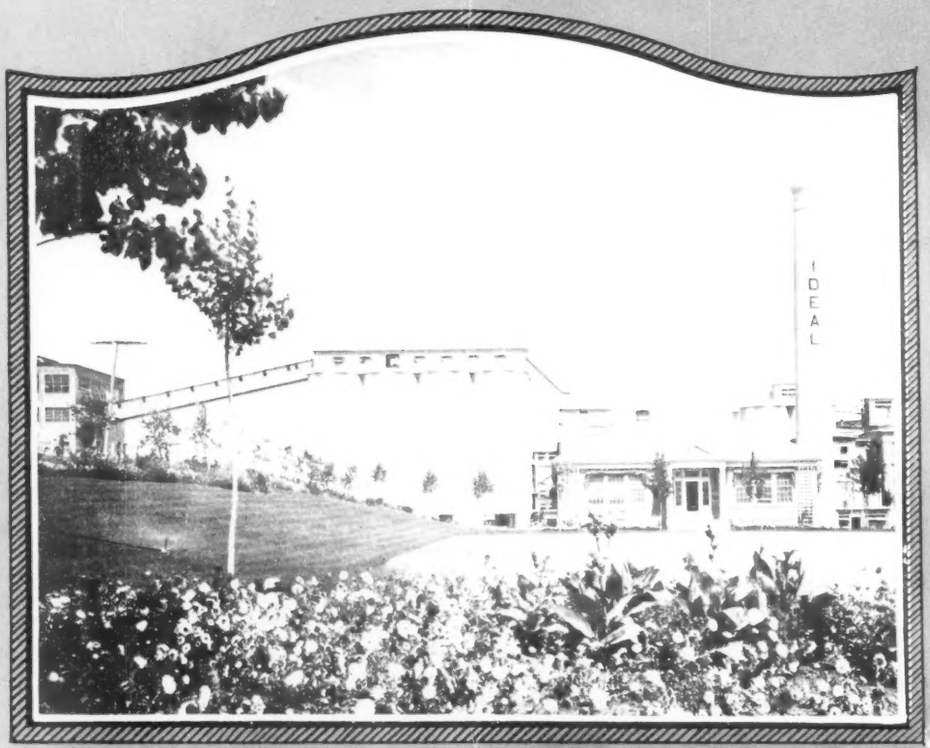

THIS TYPICALLY MODERN MILL OF THE COLORADO PORTLAND CEMENT COMPANY CAN RIGHTLY BOAST AN UNCOMMONLY ATTRACTIVE SETTING

Sacambaya Treasure Hunt
J. H. Shotton

Second Musconetcong Tunnel Nears Completion
R. G. Skerrett

Utah's Beet Sugar Industry
A. S. Taylor

Mining Gold at the Central Eureka in California
E. H. Dickenson

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n-847-LC

In Public Life

County Commissioners of Kewaunee County, Wisconsin, have five Waukesha Portable Power Units, some of which have seen six years service in road maintenance. Operating at wide open throttle on rock crushers is only possible with engines designed solely for that kind of a job.

Waukesha Power was chosen by the Russell Grader Company for the equipment owned by the Ohio State Highway Commission because of such records. Write for Bulletin No. 556.

N-869-LC

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The Carbic Flood Light is particularly well suited for underground illumination. It is endorsed by every safety engineer who has seen it demonstrated.

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The Carbic Light is built for hard service. It is simple. It can be charged in 3 minutes. It has unique safety features. The Underwriters' Laboratories, Inc. list the Carbic Light as standard.

Thousands of Carbic Lights are in use above ground. For 14 years they have been supplying dependable and economical light to contractors and railroads for night work.

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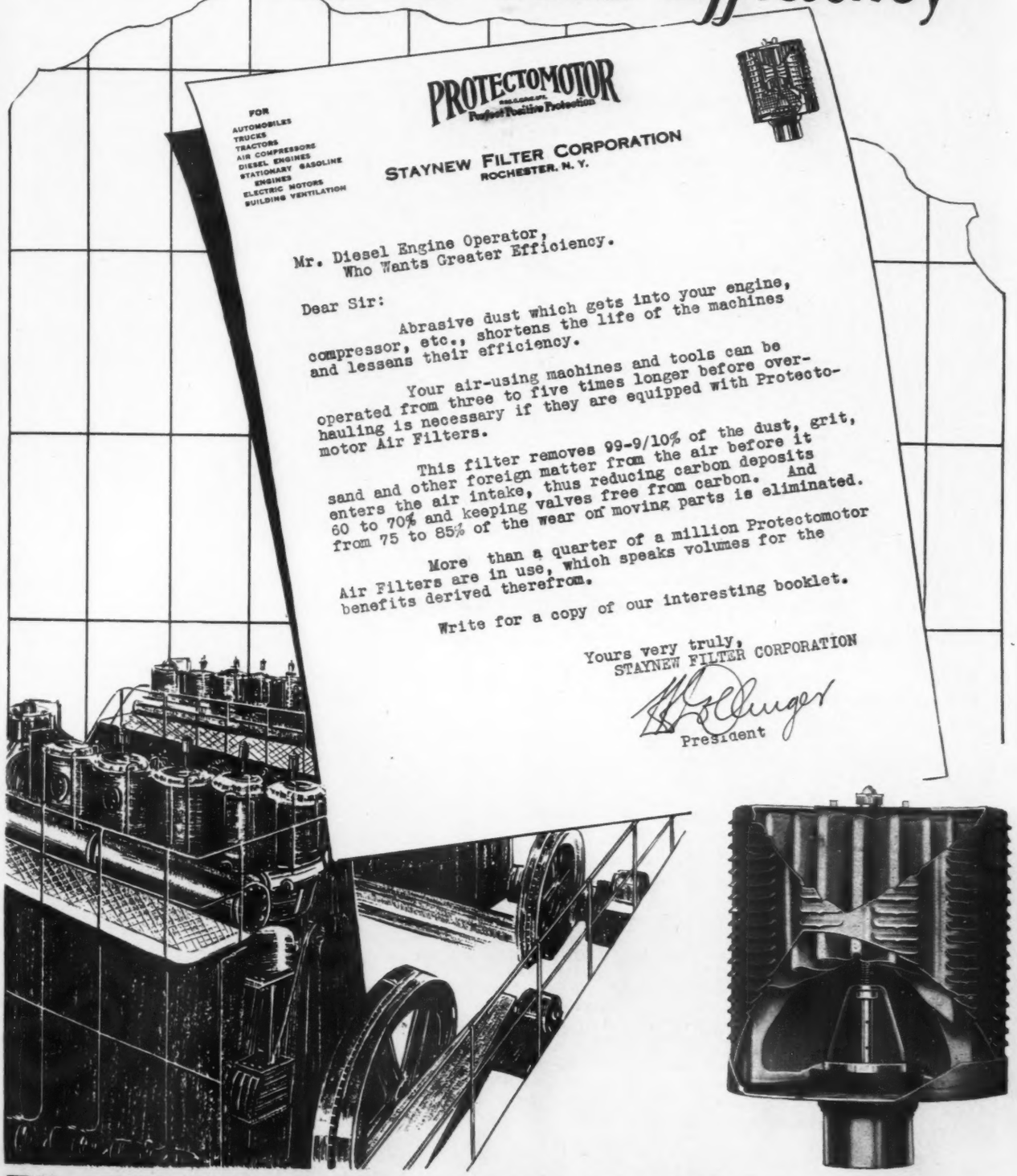
An Open Letter ....
on Air Filter Efficiency



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Yours very truly,
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President

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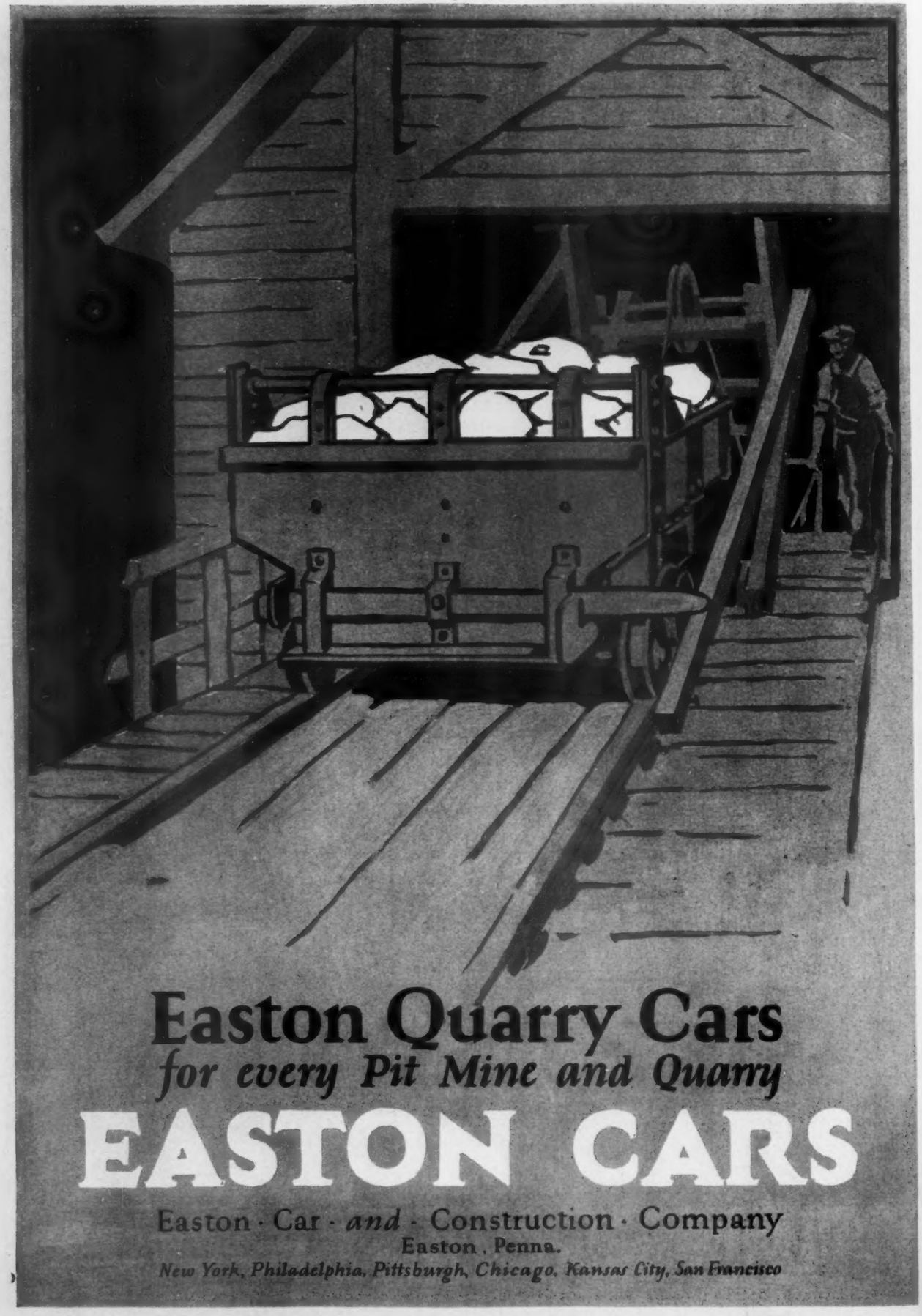
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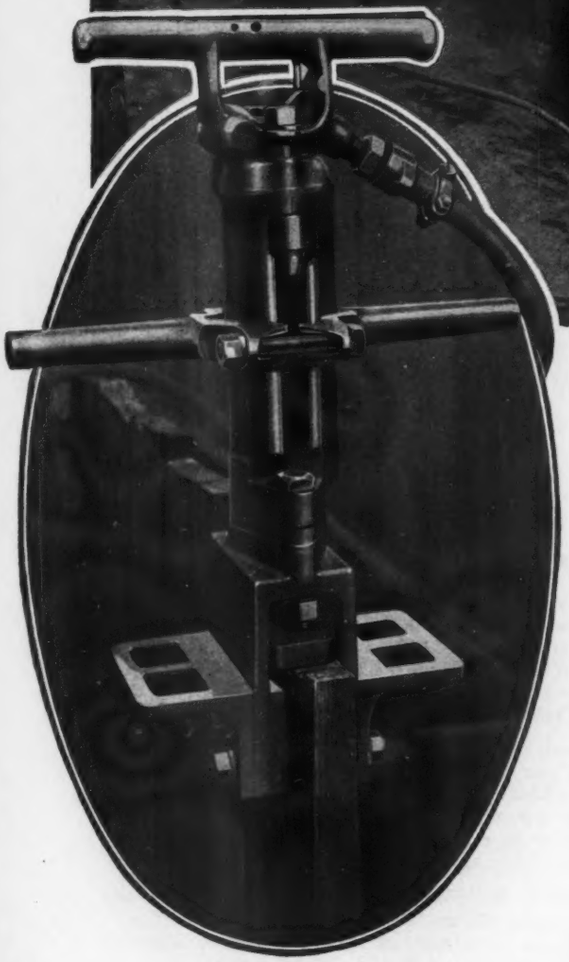

Does The Work of 12 Men

In actual operation, the I-R Pile Driver has demonstrated that it will do the work of 12 men with hand mallets. Not only is it much faster than a hand gang, but it puts down the piles without "brooming" or splitting the ends.

In sand, in clay, in broken ground, the I-R Pile Driver pays for itself in a few days' time.

The above illustration shows two of the new Pile Drivers at work in South Ozone Park, Long Island, N. Y. This job meant the laying of 15,000 feet of 36″ sewer main through soft sand. The sheet piling was driven down at the rate of 2 to 7 ft. per minute. The piles consisted of 2″ x 6″, 2″ x 8″, and 2″ x 10″ planks, 12 ft. in length.

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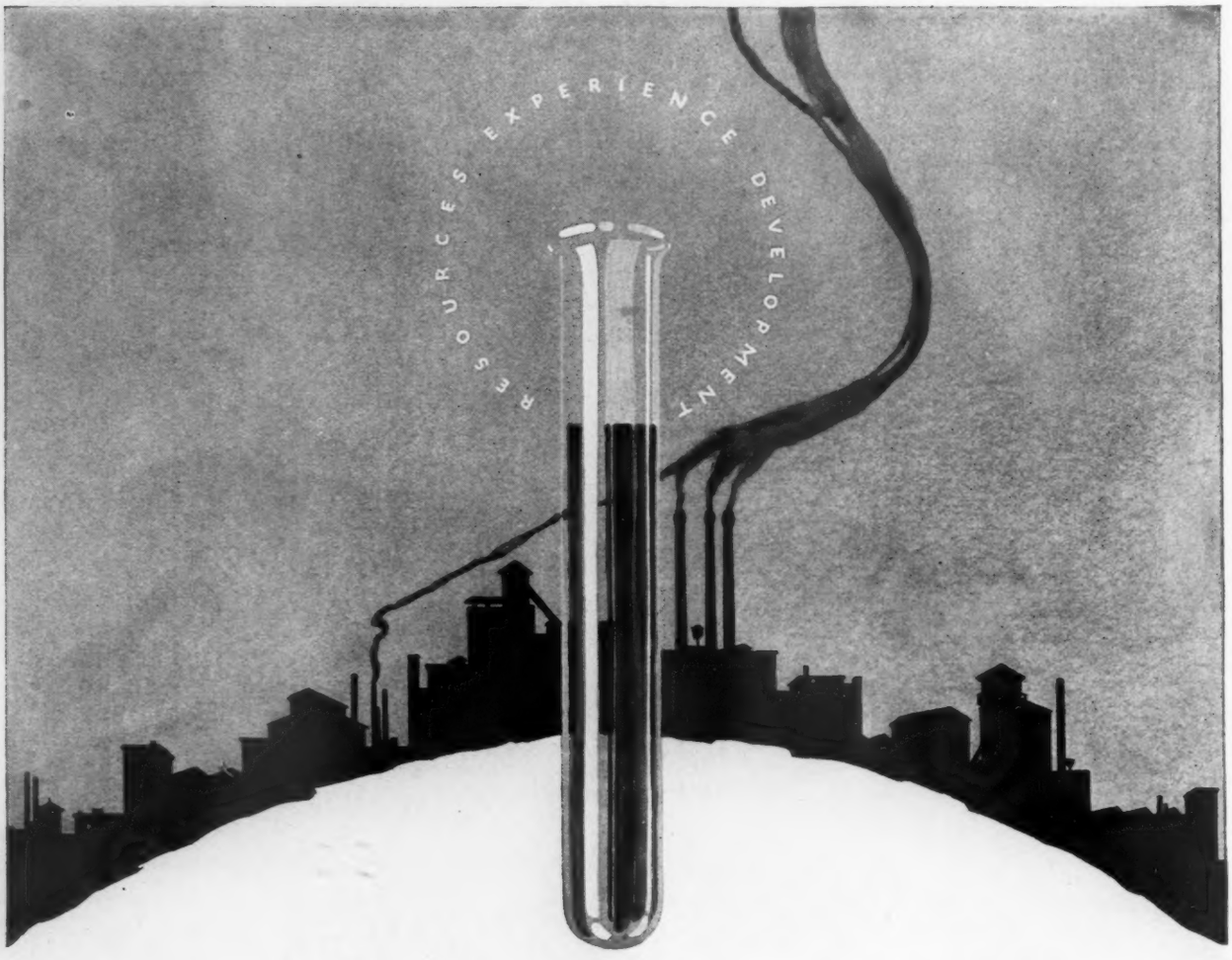

If it's made of rubber, look to Goodyear

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"Goodyear for rubber" has become a truism in business which you will do well to heed. If you would like to know what Goodyear can do for you, write to Goodyear, Akron, Ohio, or Los Angeles, California.

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Victaulic Couplings provide flexible joints that are also expansion joints for the pipe lengths they connect. They assure a strain-free line that will neither pull apart nor buckle when extreme temperatures cause the pipe lengths to contract or expand. Line sag, shifting the line sideways, pressure shocks or heavy vibration will not cause Victaulic Couplings to leak. The couplings will outlast the pipe they connect. They are all-purpose couplings for every joint on the line. They cut the cost of every mile of pipe laid.

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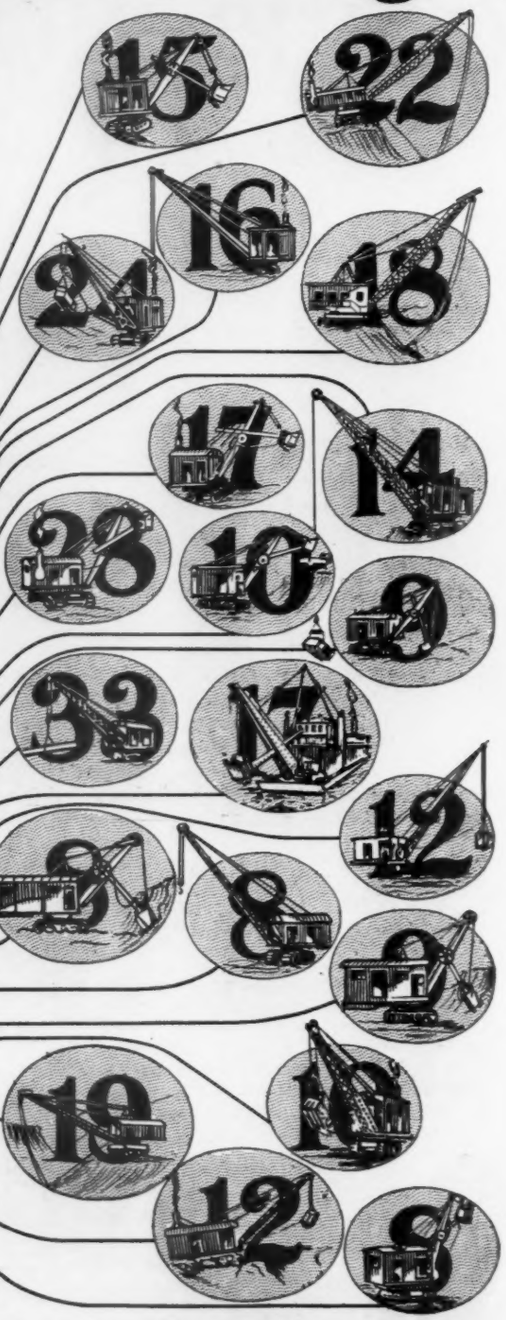
—and many more firms of the same calibre have consistently bought BUCYRUS-ERIES, year in and year out.



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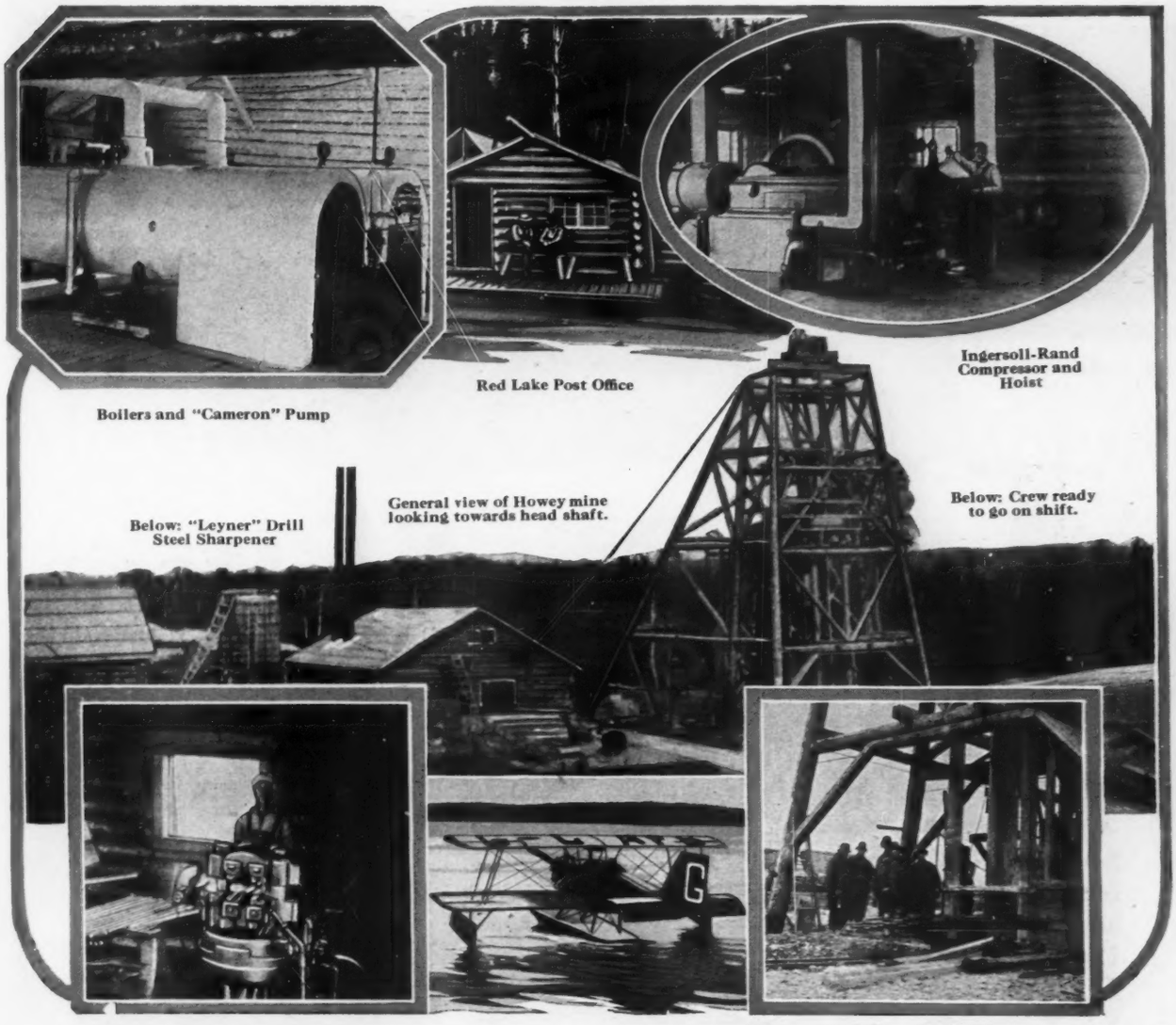
Boilers and "Cameron" Pump
Red Lake Post Office
Ingersoll-Rand Compressor and Hoist
Below: "Leyner" Drill Steel Sharpener
General view of Howey mine looking towards head shaft.
Below: Crew ready to go on shift.

Meeting Adverse Conditions

The above views show typical scenes in the Patricia Mining District of Canada. There, as in all other mining areas throughout the world, Ingersoll-Rand equipment contributes much to efficient, economical production methods.

Mining operations are paying in many remote sections today. For one reason, plants are so designed that they can be readily transported under difficult conditions; for another they are built to operate with the type of drive and the class of labor available.

The equipment for the Howey mine pictured above was taken in over 128 miles of snow-covered roads in the dead of winter. Two months later the plant was in operation, and during the next 10 months, 600 feet of shaft and stations and 1700 feet of cross-cuts and drifts on four levels had been completed.

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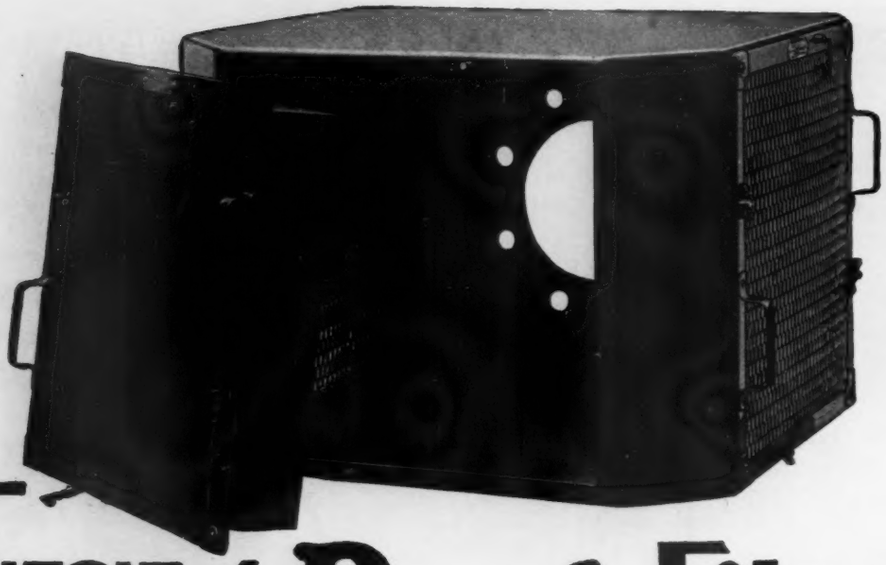

Try Reed Filters on this *Money-Back* Basis!

EIGHT years ago the very thought of cleaning the intake air for engines and pneumatic equipment was considered absurd. Today, 95% of the engine and compressor manufacturers in the United States recognize the need for air filters and recommend their use even where so-called "clean air" is available. *Without proper protection from air-borne abrasives, your engine or compressor cannot continue to function within 25% to 75% of its original rating and efficiency.*

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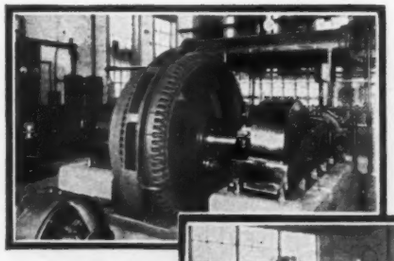
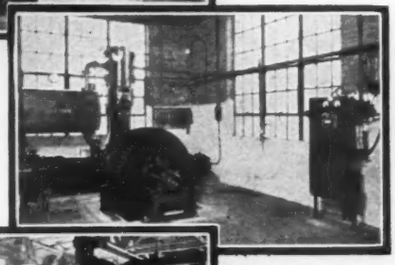
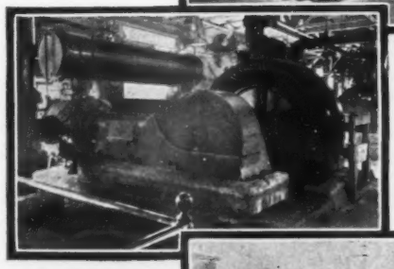


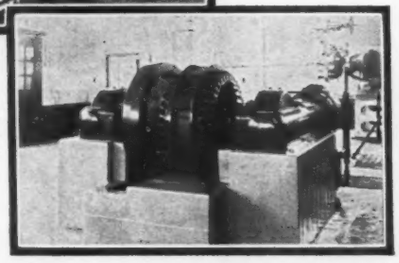
HR motor driving Worthington compressor in Ohio.



HR motor driving Sullivan compressor in New Mexico.



HR motor driving Chicago Pneumatic compressor in Pennsylvania.



HR motor driving Ingersoll-Rand compressor in California.

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The modern HR Synchronous motor fulfills all requirements for successful and economical compressor drive:

It has the known strength and rigidity of arc welded steel.

It can be assembled easily and quickly on any make of compressor.

Its operating economy is high on account of its uniformly high efficiency between fractional and full loads.

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It has the in-built quality of Westinghouse engineering and manufacturing skill.

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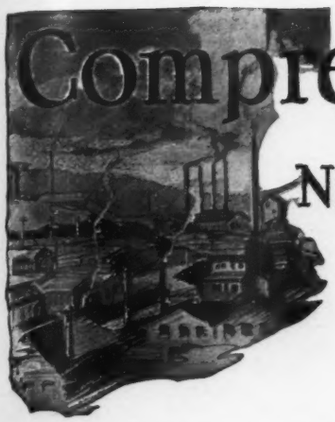

Compressed Air Magazine

NEW YORK · LONDON · PARIS

Principal Offices
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VOL. XXXIII, No. XI

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NOVEMBER, 1928

Second Musconetcong Tunnel Nears Completion

New Project Shows Progress Made Since 1872 in Devising Mechanical Aids for Engineers and Contractors

PART I

By R. G. SKERRETT

MUSCONETCONG signified much to the engineering profession half a century ago. Then it was that the Lehigh Valley Railroad drove a tunnel through Musconetcong Mountain, in New Jersey, in order to reach a tidewater terminal adjacent to the Port of New York. The completion of the Musconetcong Tunnel called for the mastery of a number of momentous physical difficulties, and it marked an outstanding instance of the employment of mechanical facilities in place of hand labor so as to finish the undertaking with all practicable dispatch.

By the end of the present year a second tunnel will be ready for service through Musconetcong Mountain; and again the engineering fraternity will have ample reason for interest in the consummation of a task that has put the contractor's resourcefulness to a test on numerous occasions since the work was started in May of 1926.

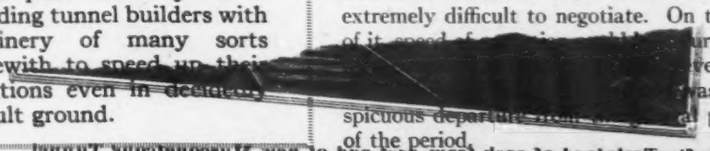
Because of a steadily increasing volume of traffic, the Lehigh Valley Railroad decided two years ago to drive a second tunnel through Musconetcong Mountain parallel with the old tunnel and 130 feet south of it, measured from center to center. The nearing completion of the project enables us to visualize the engineering progress that has been achieved in this field of endeavor in the course of the past 50-odd years. Dr. Henry Sturgis Drinker was resident engineer on the first Musconetcong Tunnel from the beginning of the work in 1872 until its completion in 1875; and it is from his classical writings that most of our information having to do with that tunnel is drawn.

Before the original Musconetcong Tunnel was opened to service the Lehigh Valley Railroad had its eastern terminal at Easton, Pa., about twelve miles west of the tunnel site. Surveys made during the autumn of 1871 and the winter of 1871-72 disclosed that a tunnel piercing Musconetcong Mountain would provide the desired outlet route to the coast and insure the greatest operating economy in extending the line's heavy coal traffic to tidewater. Construction began in the spring of 1872; and the importance of the undertaking justified the employment of every means that would be likely to hasten completion.

A SECOND tunnel through Musconetcong Mountain on the line of the Lehigh Valley Railroad will soon be finished, thus providing that enterprising railroad with means to take care expeditiously of its increasing volume of traffic. The new tunnel runs parallel with the old tunnel, but 130 feet south of it, measured from center to center.

The old tunnel was started in 1872 and completed in 1875 after a battle with inundating water that held up progress for substantially a whole year. The old Musconetcong Tunnel was rightly considered in its day a great engineering achievement; and its accomplishment was largely due to the use of all mechanical aids available at the time—outstanding among these being air compressors and pneumatic rock drills, then relatively in their infancy.

The driving of the new tunnel exemplifies in many ways the advance that has been made in the past 50-odd years in providing tunnel builders with machinery of many sorts wherewith to speed up their operations even in

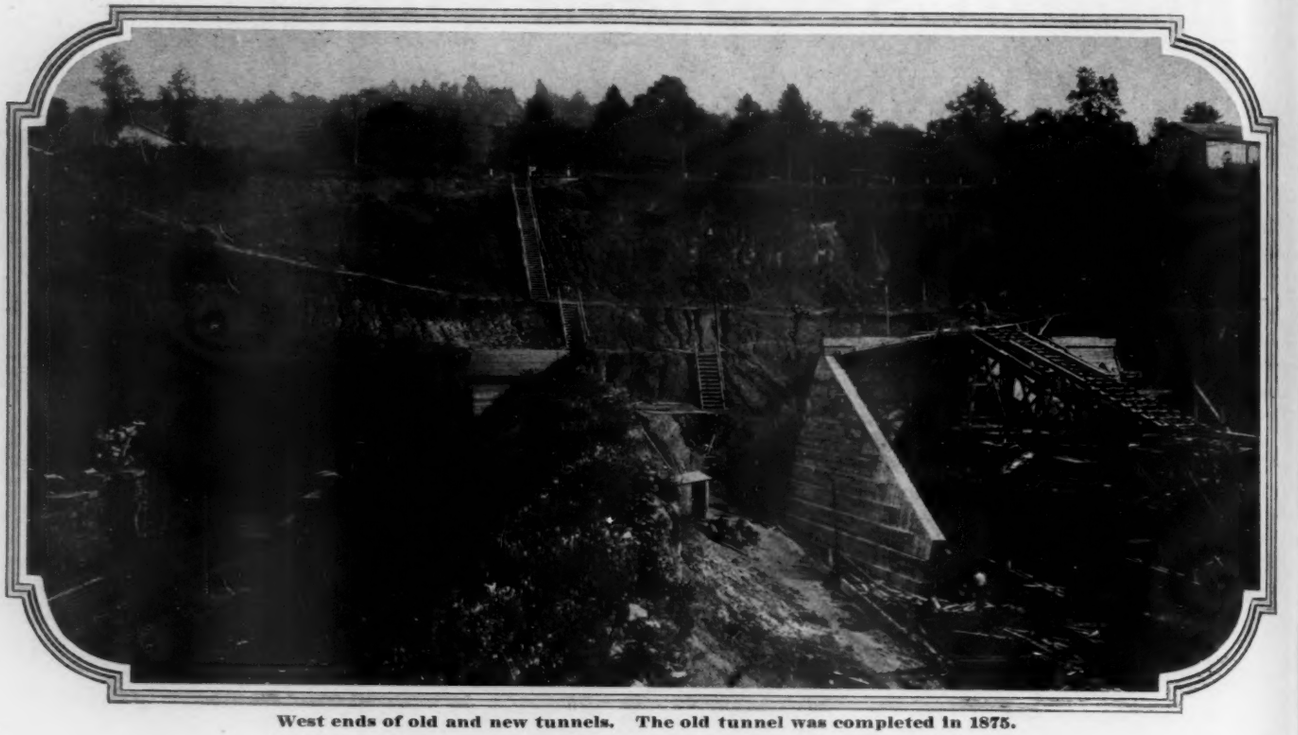


difficult ground.

The old tunnel has a length of 4,829 feet; and the rock section is 26 feet wide and 21 feet high. When driven, and for years afterwards, that section was sufficient to accommodate two tracks carrying the rolling stock then in use. Eventually, the augmented dimensions of both locomotives and cars made it impracticable to utilize more than a single track through the tunnel, even though the railroad became 4-tracked up to each portal. The new tunnel has a cross section large enough for double tracking and for the safe passage of any cars and locomotives now in service or contemplated.

When the old tunnel was driven, the site of the west portal—for more than two years after work was started—was fully a mile away from the nearest railroad station, and all materials had to be carted to that portal over rough country roads. In the case of the east portal, the journey was five miles long and over mountain roads that were often extremely difficult to negotiate. On the face of it, speed of [illegible] ured only [illegible] ver possi- [illegible] was a conspicuous departure from [illegible] practice of the period.

Left—Trimming of rock from east end of new Musconetcong Tunnel. Right—at east end of new tunnel. The Marion shovel



West ends of old and new tunnels. The old tunnel was completed in 1875.

Steam for power purposes was utilized wherever it could be employed to advantage; but the use of steam involved the burning of coal that had to be hauled to the bases of operation. The transporting of that fuel entailed a heavy expense and necessitated the continual service of twenty-four 4-horse teams. Doctor Drinker has recorded that "About 1,000 tons of soft coal were burnt in the course of the work by the steam shovels, blacksmith shops, and locomotives; and it took about 26,500 tons of anthracite, in the three years, to supply steam for the slope and shaft hoisting engines and pumps, and the west- and east-end compressors." Picture what this meant to the horse-drawn teams when toiling up steep stretches of the roads, especially during stormy or winter weather!

Further, Doctor Drinker tells us: "To expedite the work, the contractor had in use the latest and most approved machinery, and no means were spared to push the work in every possible manner. The plant found necessary comprised: 26 Ingersoll drills; 4 Burleigh and 4 Rand & Waring compressors; 4 return-tubular boilers at the west end and 5 large locomotive boilers at the east end; 2 machine shops with repairing outfit, one at each end; about 1½ miles of 6-inch air- and water-pipe; 2 hoisting engines, one each at the slope and shaft; 4 locomotive boilers to run them; a number of steam pumps in constant use; 2 steam shovels, for removing the west-end open cut, run constantly day and night; and 2 small locomotives to run out the open cut, and such of the tunnel material as could be brought out of the entrance."

The slope referred to in the preceding paragraph was an inclined shaft 275 feet deep driven from the mountainside eastward and downward so as to intersect the tunnel line in supposedly solid rock—the object being to increase the number of headings from which the work could be advanced. The plan was a good one; but Charles McFadden, the contractor, had not reckoned with the unexpected. When the heading progressing eastward from the slope had penetrated the limestone less than 300 feet, water was encountered. The hidden reservoir was tapped by a 2½-inch drill hole driven about 4 feet above the floor of the heading. "The water forced the drill back and shot some 50 or more feet out into the heading in a steady stream, seeming to come from some large, pent-up reservoir

Left—Trainload of rock from east end of new Musconetcong Tunnel. Right—Timbered portal and start of bench excavation at east end of new tunnel. The Marion shovel is air operated.

1—Drilling equipment leaving east portal of new Musconetcong Tunnel. 2—The No. 50 "Leyner" sharpener and the No. 25 Ingersoll-Rand oil furnace in the blacksmith shop at east portal. 3—Drill-service station and blacksmith shop at east portal, showing some of the R-72 drifters used in drilling the rock. 4—A "Little Tugger" hoist lifting cars to top of core from plumb-post drift in west portal. 5—One of the several air-operated Cameron piston pumps used for dewatering the new tunnel.

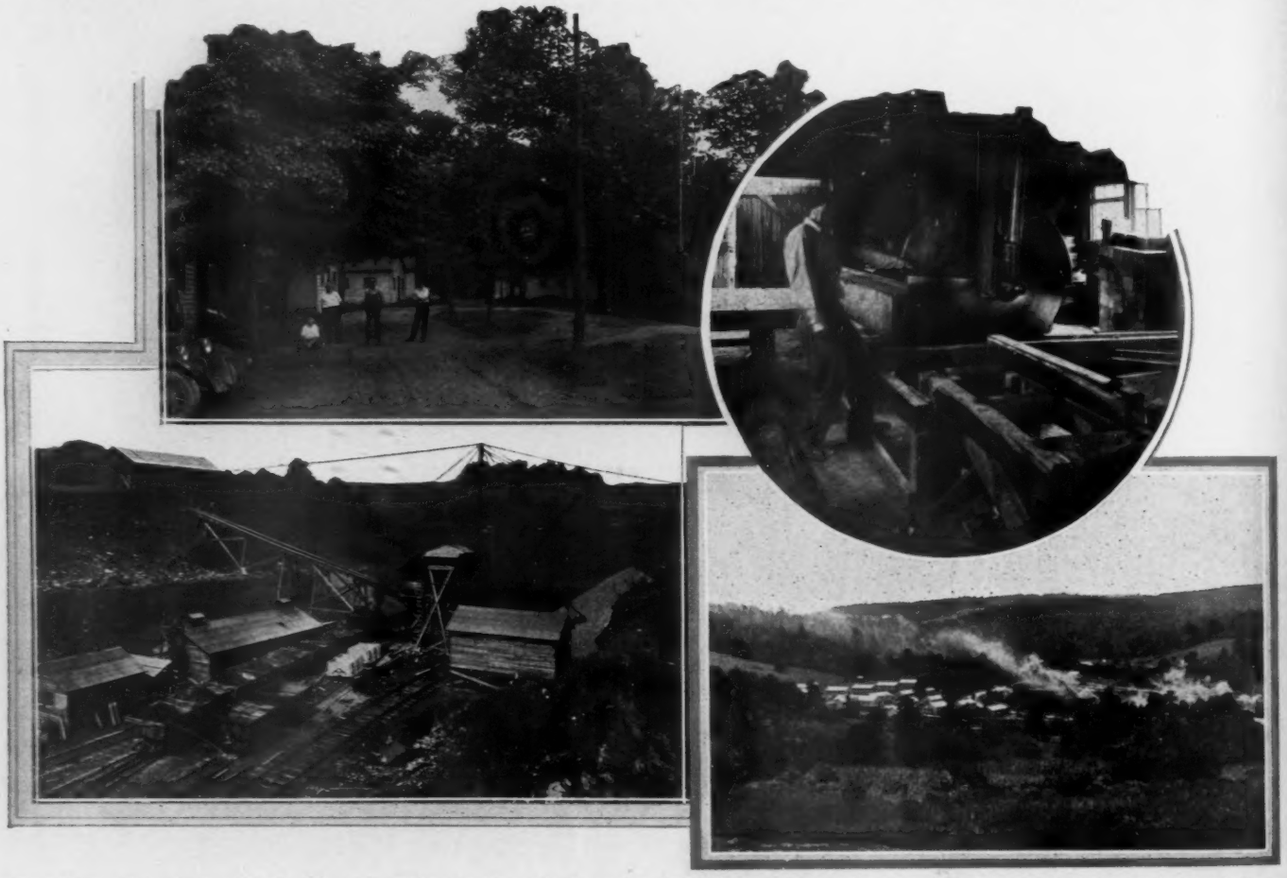
The drifts and a considerable part of the inclined shaft were flooded despite the pumps. This occurred on May 7, 1873; and for many months afterwards no more work could be done in the shaft and the associate headings.

A second shaft, 100 feet deep, was sunk to the tunnel line at a point nearer the west portal; but the eastward heading from that shaft struck water-bearing rock when it had been advanced a distance of 165 feet. The incoming water flooded the workings and the shaft to a height of 40 feet. When the workings could be pumped dry, a cross cut was driven and a paralleling drift advanced to get around the troublesome heading and possibly by the water-bearing stratum. But water was encountered repeatedly, and each time the workmen were forced to retreat to the surface. In August of 1874—more than a year after water began to cause difficulties, the drills again opened up the seemingly exhaustless reservoir, and water poured into the workings at the bottom of the vertical shaft at the rate of 3,000 gallons a minute.

To make a long story short, the situation at the original sloping shaft remained unaltered in the meantime, and no progress at the west portal could be effected except in removing the rock in the intervening dry section. When the heading from the portal was holed through so as to provide an outlet for the water flooding the workings at the bottom of the vertical shaft, then the water in the hidden reservoir had a chance to exhaust itself by way of that portal; and in less than an hour the flow ceased, although for a while it poured forth to the full capacity of the drift. Thereafter it was practicable to unwater the workings at the bottom of the sloping shaft and to resume driving eastward. The release of the water then probably accounts for the extremely moderate amount met with in driving the new Musconetcong Tunnel, in which the inflow at no time has exceeded 500 gallons a minute—air-driven Cameron pumps being easily capable of handling it.

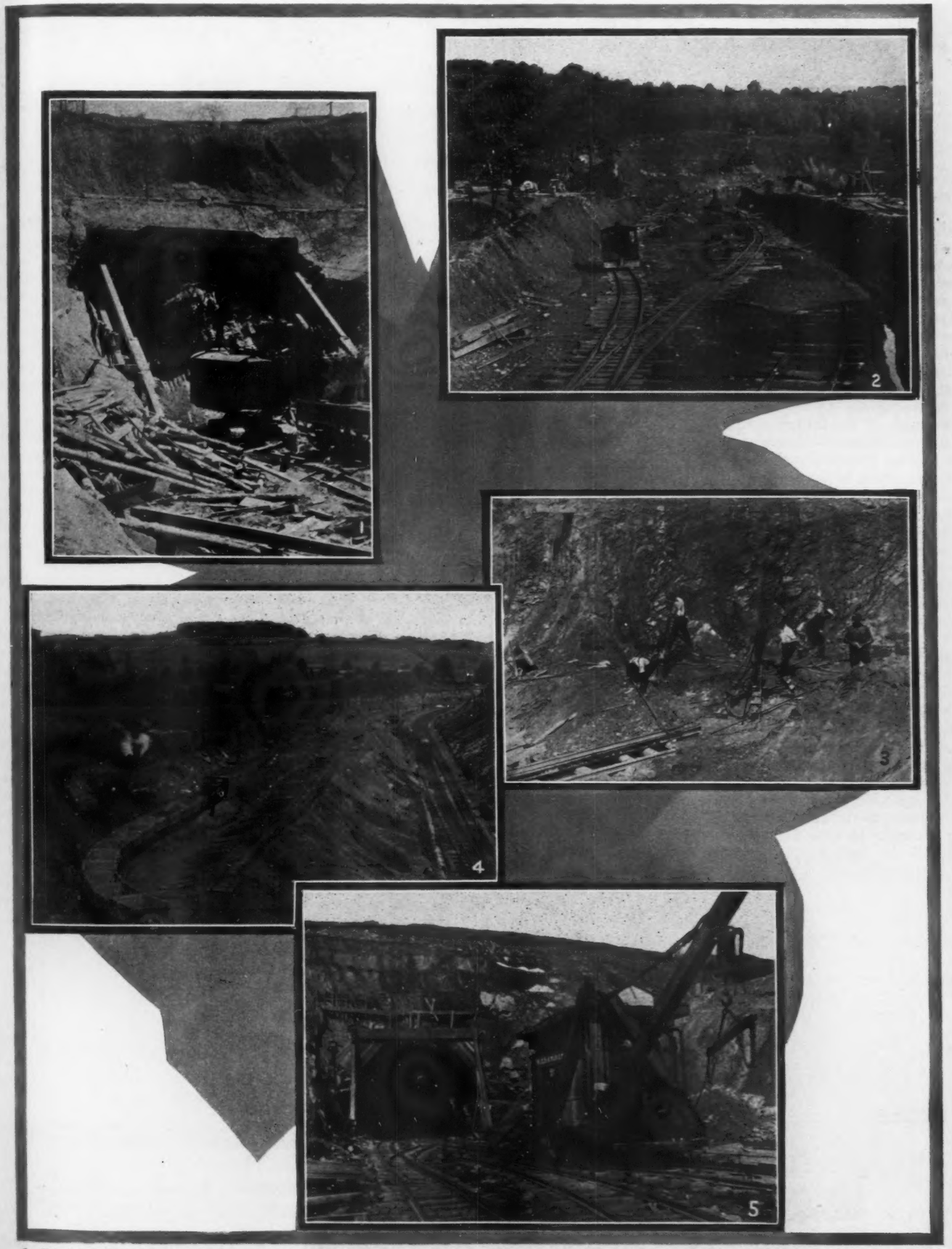
The air-driven drills used in driving the old Musconetcong Tunnel were the invention of Simon Ingersoll, and were brought out in 1871. Those drills represented a decided step forward in the art, and were chosen by the contractor for the tunnel because they were considered by him to be the best available for the work in hand. The Ingersoll drills performed well; and Doctor Drinker has written of them: "At first 3½- and 4-inch drills were tried, but finally the 5-inch drill was decided on as by far the best size in the hard rock encountered. This drill was found to run months with little or no repairing necessary, and such repairs as were needed were generally more in consequence of wear than breakage." The drills were mounted on crossbars supported by timber carriages—each carriage mounting three drills; and two carriages were used at each heading, one on each side of the center line. The machines were piston drills, and the steel was directly connected to the piston—the size of the drill being designated by the diameter of the piston.

According to the record: "After the machines got fairly to work at the west end, they made an average, in the six months beginning June 1, 1874, of 135 feet per month through rock which was pronounced harder and tougher than any met with in the Hoosac Tunnel by judges familiar with both." Exclusive of the rock removed in the two approach cuts to the portals, a total of 82,000 cubic yards of rock was excavated in the tunnel proper. Black powder was employed generally for blasting in the open cuts, where the drilling was done by hand, while almost all the rock removed within the tunnel was blasted with dynamite that was fired electrically. The use of dynamite and electric firing were notable innovations. The tunnel was completed in 1875; and at the high tide of operations there were 1,000 men on the job.

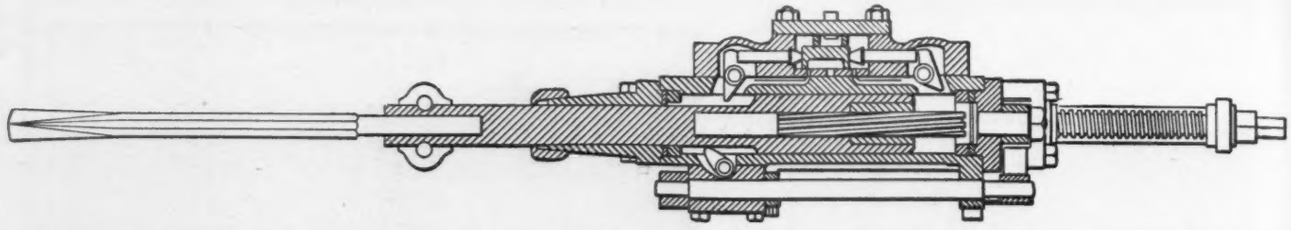


Top, left—Camp at east portal of new Musconetcong Tunnel. Right—Contractor's sawmill at west portal. Bottom, left—Concrete mixer and shops at west portal. Right—Panoramic view of camp at west portal.

The new Musconetcong Tunnel is 4,900 feet long between portals. The lined sections are 30 feet wide and 25½ feet above the base of the rails at the crown of the arch. The excavated sections average 39½ feet wide and 34 feet high in soft ground; 36 feet wide by 31 feet high in rock, before lining; and 30 feet wide by 28 feet high in solid rock, where unlined. Inasmuch as most of the tunnel is lined, it is highly likely that the remainder of



1—Timbered portal at west end of new tunnel, with an Osgood shovel excavating the bench. 2—At work taking out cut to grade at east approach. 3—Drilling rock in east approach cut. 4—Bucyrus-Erie shovel and muck train taking out the first lift of the excavation for the approach to west end of new tunnel. 5—This air-operated shovel is equipped with an air hoist for lifting and transferring empty muck cars from the side track to the loading track.



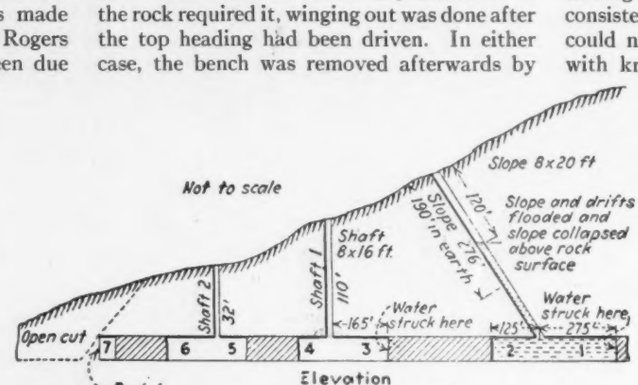
Longitudinal section of the 5-inch Ingersoll drill used between 1872 and 1875 in driving the original Musconetcong Tunnel.

it will be lined sooner or later for the sake of uniformity. Where lined in heavy ground the side walls are 4 feet thick, and the arch lining is generally 3 feet thick. In good ground, however, there is a 2-foot concrete lining.

The present job has been exceptional because of the wide range of demands made upon the contractor, the Bates & Rogers Construction Company. This has been due to the diversity of ground encountered within the relatively short length of the tunnel; and the frequent changes of formation have imposed correspondingly frequent alterations in the methods or procedures employed to deal with them.

For a distance of 750 feet in from the west end, the formation penetrated is composed of clay, oxidized clay, shale, and decomposed syenite. Following this, the tunnel pierces 450 feet of soft limestone; and then the heading was advanced through 300 feet of loose and broken water-bearing syenite. This formation is part of the old watercourse that was tapped when the original tunnel was driven; and, because of the broken nature of the ground, the drill runners frequently found it troublesome. In the remainder of the tunnel, working eastward from the west end, a hard syenite was prevalent; and the rock might appropriately be described as a gneiss.

In soft ground, where enormous pressures were developed, especially when the ground was wet, the crown-bar method of tunneling was resorted to; and this procedure was extensively used in the western section of the tunnel. The crown-bar method was followed at the east end of the tunnel for only 450 feet—solid rock being struck thereafter. In solid rock, the work was advanced by the familiar top-heading method—the full width of the heading being driven at one time, as a rule. In some cases, where the condition of the rock required it, winging out was done after the top heading had been driven. In either case, the bench was removed afterwards by bench holes and toe holes. Occasionally, down holes were employed to break away the top corner of the bench. Depending upon the nature of the ground encountered, the length of the bench behind the heading varied from 10 to 20 feet.



Courtesy, Engineering News-Record.

Vertical section and plan of operations carried on at the west end of the old Musconetcong Tunnel, where in undating water delayed the work for many months.

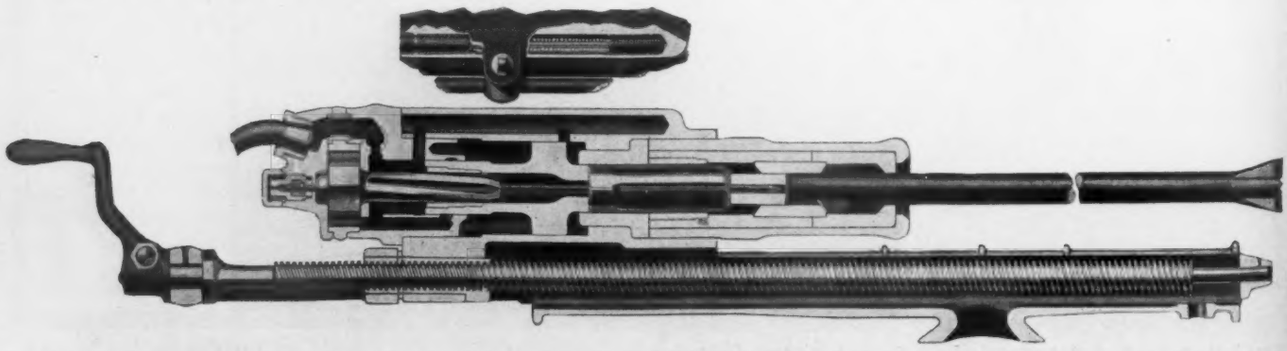
(To be concluded)

CUTTING GREASE WAFERS WITH AIR PRESSURE

NOT long ago when the Maine Central decided to use hard grease in locomotive driving-rod grease cups it was found that the consistency of the substance was such that it could not be cut into wafers of suitable size with knife blades. Tests revealed that the work could be done with thin wires under pressure; and, as a result, a cutting machine was devised at the Waterville, Me., shops of that railroad that can turn out 469 grease wafers at one stroke. This machine, as well as the forming machine which converts the grease cakes into rolls 1½ inches in diameter, is operated with compressed air.

The frame of the cutting machine, so *Railway Mechanical Engineer* announces, is fashioned of heavy-oak timbers. Over an opening in the machine table are stretched 67 piano wires, and on these are laid seven rolls of grease each 28 inches long. The wires are spaced to cut wafers ⅜ inch thick. The grease is pressed through the wires by a platen, on the bottom of which are seven wood strips shaped to conform to the contours of the rolls. These strips are slotted so as to accommodate the wires after they have finished their work of cutting. Pressure is applied to the platen by means of an 8x12-inch air-brake cylinder; and a valve placed in the air line reduces the regular shop air pressure to the required 35 pounds.

An iron industry is to be established at Puerto Corral, Chile.



Longitudinal section of the R-72 Ingersoll-Rand drifters extensively employed in driving the new Musconetcong Tunnel for the Lehigh Valley Railroad.

New Grace Motor Liner "Santa Barbara" Sails on Maiden Voyage

By W. P. BIESER*

THE new twin-screw motorship *Santa Barbara* of the Grace Line, displacing 15,000 tons and with a speed of well over 16½ knots, sailed on her maiden voyage for the west coast of South America via Havana and the Panama Canal on September 27. Her sister ship, the *Santa Maria*, named in honor of the flagship of Columbus, was placed in the same service on May 10, last. These new vessels are the largest and the fastest passenger-and-freight motor liners flying the Stars and Stripes. Those interested in dimensions may like to know that the *Santa Barbara* has a length of 485 feet and a beam of 64 feet; that she is equipped with engines developing 10,000 i.hp.; and that she has a cargo-carrying capacity of 7,000 tons.

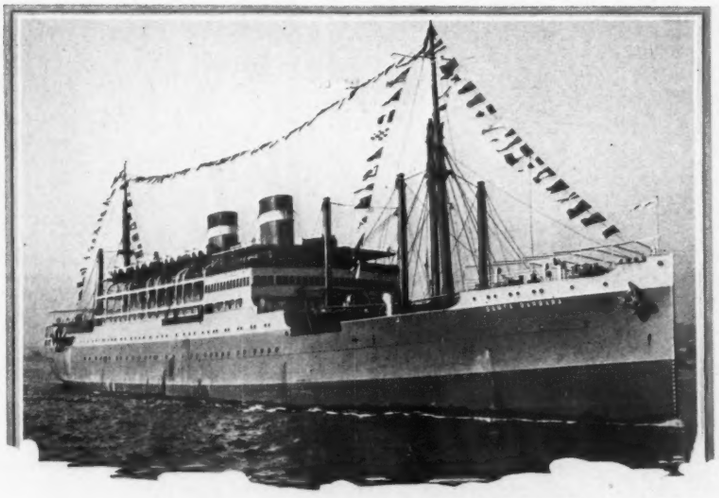


Photo by Cosmo News Photo Service.

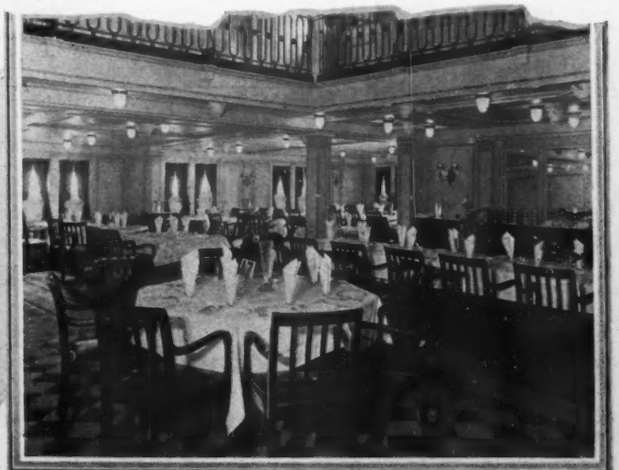
The fine motor-driven ship "Santa Barbara" of the Grace Line, having a displacement of 15,000 tons.

The American idea of making passenger ships homelike, comfortable floating residences was carried out in every detail of their design. There are numerous suites-de-luxe and a proportion of cabins with private baths formerly undreamed of. There are no inside staterooms; and beds instead of berths are the rule. Only first-class passengers are accommodated—the maximum capacity being 157. A capacious swimming tank, a space set aside for the practice of golf, wide decks for dancing, for sports, or for deck-chair siestas invited by the tropics, are interesting features of the ship arrangement. The promenade deck—on which are situated the social hall, lounge, smoking room and veranda cafe—is fitted at the forward end and for a considerable distance along each side with a glass screen with sliding windows, thus assuring comfort under all weather conditions.

Each vessel has a cruiser stern, a straight stem, and is of the 2-deck type with a shelter deck and with a tonnage opening aft. The hull is subdivided by nine complete watertight bulkheads and by a number of other bulkheads forming smaller subdivisions. Eight insulated compartments are provided for provisions, and there are six specially insulated cargo chambers for the carriage of fruit, together with three electrically driven co-refrigerating machines and the necessary fans, coolers, brine grids, etc. The galley and the laundry have the most modern electrical facilities. Ample baggage, mail, bullion, and storerooms are available. These new motor ships conform to the specifications of Lloyds and the American Bureau of Shipping.

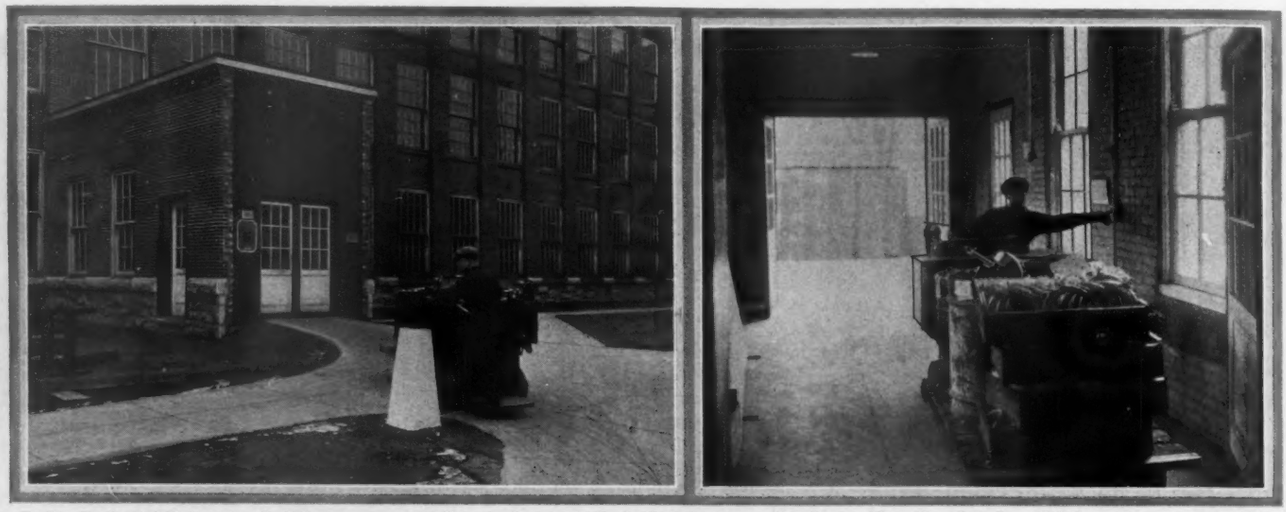
The steering gear of the *Santa Barbara* is of the 4-ram electro-hydraulic type operated both by telemotor and Sperry electric control. Electric winches are provided for boat hoisting. The deck machinery gives the *Santa Barbara* exceptional power for the heavy lifts characteristic of West Coast freight traffic. It will often be called upon to hoist single pieces of machinery weighing from 40 to 60 tons. The nature of the trade has produced in the *Santa Barbara* a fine example of high-class passenger and heavy-freight ship. Incidentally, on her trial, the *Santa Barbara* substantially exceeded her contract speed of 16½ knots.

*Editor, The Grace Log.



Photos by Drix Duryea

Left—Where all the smoker's needs are anticipated. Right—The dining room of the "Santa Barbara" is airy, light, and attractive.



Left—Industrial tractor halting momentarily at air-control station to open the doors directly ahead. Right—Tractor operator closing the doors behind him by pushing a button after entering the building.

AIR-OPERATED DOORS

IT is a recognized fact that the use of special motor trucks and tractors in large industrial establishments and the like has done much to facilitate the handling of materials in the course of manufacture or of finished commodities. This problem of internal transportation is an important one, because it has a vital bearing on the speed of production. The introduction of self-propelled vehicles of all sorts within the walls of modern plants, factories, etc., has resulted in another convenience designed primarily to prevent the slowing up of these carriers at intervening doorways, which are kept closed for one reason or another. We are referring to automatically operated doors which are finding favor in the eyes of plant managers because they are one more means of keeping things moving.

The Michigan Metal Products Company has devised a system of pneumatic door control, known as the "Air-Dor" control, that is very flexible. It can be used in connection with any standard type of straight swing door, single- or double-slide door, and folding door, and can be modified to serve special needs. For example, conveyors can automatically operate doors by the aid of special trips placed at suitable points on the trackway; and traveling cranes moving in and out of buildings can be made to open or to close doors in a similar fashion.

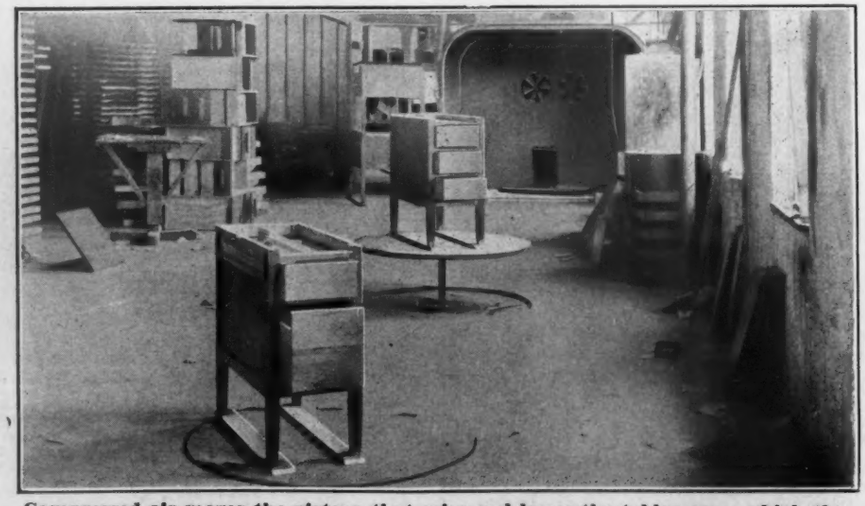
The "Air-Dor" operating mechanism is connected directly to the air-supply system in the plant, if such be available. Thence the compressed air passes through an electrically controlled valve that can be functioned by any desired number of switches, thus making it possible to open or to shut a door from convenient stations inside and outside the building. This can be done at any desired rate of speed through the medium of a pressure regulating valve, which admits just the right amount of air into the cylinder attached to the door, itself. The arrangement is such that the doors are at all times under the complete control of the operator, and may therefore be reversed at any point in their travel. The air pressure required for this service of course varies with the size and the weight of the door, and ranges anywhere from 20 to 100 pounds per square inch—60 pounds being the average working pressure. The consumption of air is said to be low.

Aside from the convenience of such a system of door control, which enables drivers of industrial trucks to be their own door tenders without moving from their places, the item of possible savings to be effected by its use deserves consideration. An automobile plant, where five doors are pneumatically operated, has reported that one of them paid for itself in six weeks of service. Within an interval of fourteen weeks this particular pair of doors was opened and closed 14,178 times.

AIR-LIFT TABLES INCREASE DESK PRODUCTION

THERE are many operations in the finishing room of a furniture factory—such as rubbing down finishing coats with sandpaper—that can be performed much more effectively if the work can be raised to any desired height quickly and without involving manual labor. This is accomplished, in a factory specializing in the making of office desks, by means of air-lift tables, three of which—one in the spray cabinet—are shown in the accompanying photograph. These tables, according to the owner, have paid for themselves many times over; and the number in use throughout the plant in question is ample evidence of their value in dollars and cents from a production standpoint.

The lifts are operated by controls, on the floor, that are similar to the accelerator of a motor car. To raise the working platform to its maximum height the operator steps on one control: to lower it flush with the floor he presses his foot on the other control. Holes at different points in the shaft or plunger, to which the table is attached, make it possible to keep the table at corresponding heights by inserting a pin in any one of them. This is a convenience, as it enables a man to place his work where he can best handle it. Facilities of this kind could, no doubt, be used to advantage in other branches of industry.



Compressed air moves the pistons that raise and lower the tables upon which the work is placed in this furniture factory.

Mining Gold at the Central Eureka In California

This Property Was Located 63 Years Ago and Illustrates the Difficulties of Working in the Mother Lode

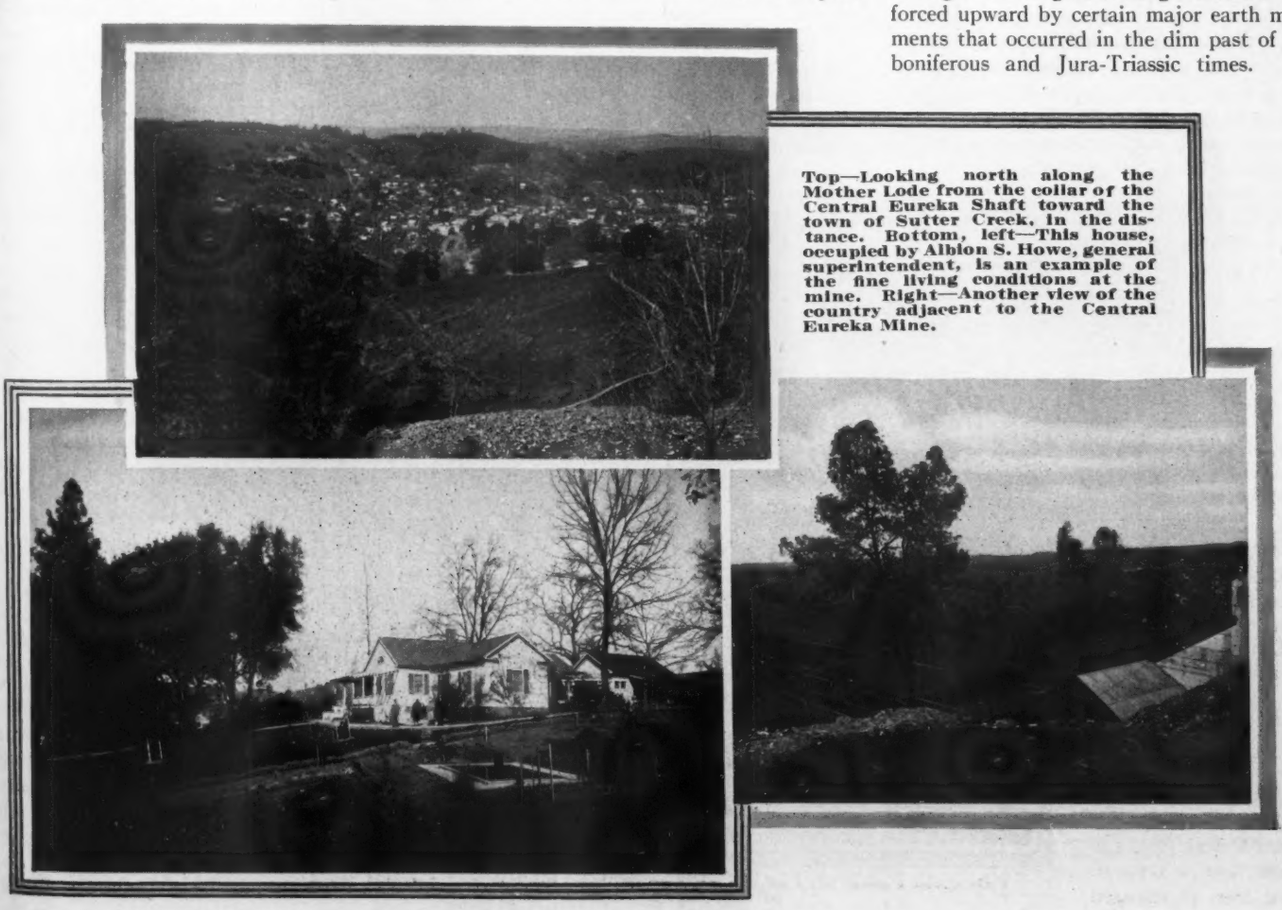
By E. H. DICKENSON

AFTER the mad rush of the "forty-niners" had petered out somewhat and many of those venturesome gold seekers cast about for more permanent employment than that of working placers, then it was that the Mother Lode was discovered—the primary source of the flecks and nuggets of the precious metal found in the beds and adjacent sands of streams running seaward from the slopes of the Sierra Nevada Mountains. Quartz mining on the Mother Lode began about 1850, and has continued intermittently ever since—the records of those undertakings being a succession of high-hearted starts with all too frequent dismal endings or with long suspensions of efforts. Many of the disappointments were, undoubtedly, due to the decidedly difficult nature of much of the ground and to the manner in which the earlier enterprises undertook to deal with the physical conditions of the lode.

All along the Mother Lode are the abandoned ruins of what once were thriving mining towns before the gold-bearing lode suddenly ceased to be a producer or before mining, as then practiced, proved unable further to cope with the ground. The region has been picturesquely dealt with in the writings of Bret Harte and Mark Twain; and in the days described by them the mining towns were communities of rough men, crude ways, and rawness in many respects. This background is interesting because it now serves to emphasize a present contrast as represented by the towns of Sutter Creek and Jackson. The Central Eureka Mine, with which we are about to deal, is at Sutter Creek, and Jackson, the county seat, is three miles away. These towns have none of the rawness of the usual new mining camp. From afar they suggest New England villages, except that the snow-capped Sierras visible in the distance reveal that such they cannot be. On closer inspection, the prevalence of palms and orange trees, of narrow streets and arcaded sidewalks, carries one back to the time when Old Spain held sway in California.

Apart from what they represent in the way of varying successes in extracting treasure from the Mother Lode, most of the mining camps are interesting historically and also because of the unusually fine living conditions offered by nature in the forms of good water, a very favorable climate, and an advantageous elevation of 1,500 feet. Fruits of every description, such as oranges, apples, peaches, nuts, blackberries, etc., grow at random about the Central Eureka Mine. Snow, though seen afar on the towering mountains, seldom falls at the mine; and the property is within 1½ hours' run from Sacramento or Stockton, and 4 hours' drive from San Francisco over concrete roads.

The Mother Lode ranges for a distance of approximately 125 miles between Mariposa County, on the south, and Eldorado County, on the north. The Mother Lode is a sheared fault zone—a line of crustal weakness, through which gold-bearing solutions were forced upward by certain major earth movements that occurred in the dim past of Carboniferous and Jura-Triassic times. This



Top—Looking north along the Mother Lode from the collar of the Central Eureka Shaft toward the town of Sutter Creek, in the distance. Bottom, left—This house, occupied by Albion S. Howe, general superintendent, is an example of the fine living conditions at the mine. Right—Another view of the country adjacent to the Central Eureka Mine.

fault in places has been found to carry gold-bearing quartz. So much for the Mother Lode as a whole. Now let us touch upon the activities of the Central Eureka Mining Company.

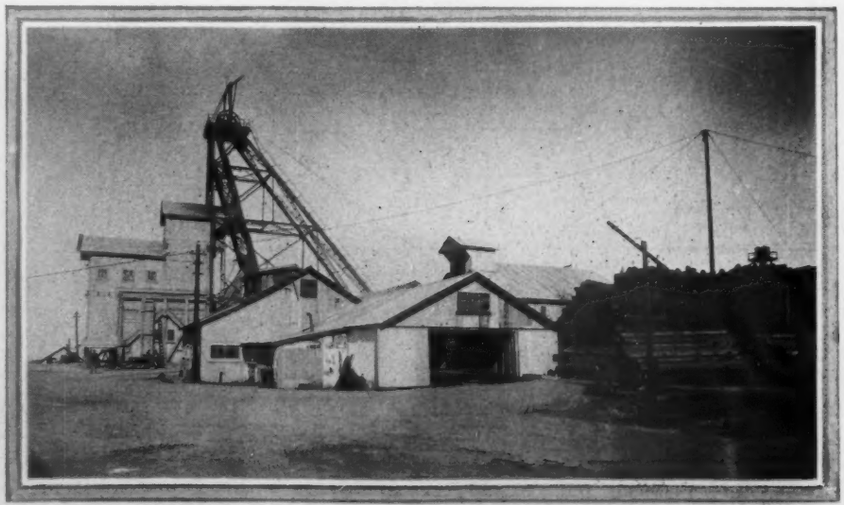
There are three original properties, all of which are now connected underground. These are the Central Eureka, where the present main shaft is located; the Old Eureka, which the Central Eureka Mining Company owns; and the South Eureka. An accompanying sketch shows the relation of the three properties. The Central Eureka Mine was located in 1865, and was worked to a depth of 600 feet through a shaft at the north end of the property—the ore being shipped to a local custom's mill. About 40 years ago the vein was lost and the mine closed down. It was next worked to a depth of 2,700 feet through the present Central Eureka Shaft. This shaft then caved in, and the headframe fell into the hole. At the same time, the South Eureka Shaft, 1,200 feet away, also caved. The mess was cleaned up by sinking an inclined shaft under the cave to connect with the bottom portion of the old shaft. The new shaft at present extends to a depth of 4,960 feet on a 70° incline. It is interesting to note that the Old Eureka once belonged to Mrs. Hetty Green. The story is that she refused to work it or to have it pumped out, and that finally she sold it full of water for half a million dollars.

Shaft collar at the Central Eureka Mine.

From a mining viewpoint, the property is interesting because of its depth, the extremely heavy ground encountered, and the amount of timbering required to support it. According to Albion S. Howe, the general superintendent of the company, the ground presents no rock drill problems: the difficulty is to sustain the ground, not to break it. Just what the situation is can be appreciated when it is considered that an average of three timbermen are employed to every two miners.

Today, instead of the original vein, a newly discovered lode in the footwall is being worked. It is for this reason that the lowermost section of the Central Eureka Shaft is in the hanging wall of the vein; and this accounts in part for the very heavy ground at the bottom of the mine. It is also due to faults cutting the vein at acute angles. Despite the fact that the shaft is supported by round timbers, each 2 feet in diameter, with 8x14-inch jacket sets outside these, it has been necessary during the past year to replace all the timbers up to a point 200 feet from the bottom; and a crew of fifteen men is engaged on this work nearly all the time. There is an interval of 150 feet between levels. The timbers are of pine, spruce, and Douglas fir.

The method of stoping employed depends upon the nature of the ground—that is, whether quartz, broken-up slate, gouge, or quartz stringers are being mined. The stopes have a maximum width of 35 feet. A timber-and-fill system is practiced—the timbering consisting of a modified form of square sets differing from those in common use in that the caps run from wall to wall, like stulls. Some of the chutes are cribbed with round timbers. The needful waste or fill is taken from crosscuts run into the walls at angles of from 35° to 40° so that the muck will slide out of them. These crosscuts are driven into either the hanging or the footwall, whichever happens to be more convenient; and the muck so obtained is shoveled into place in the stopes.



This gives a good idea of the neat conditions maintained around the shaft of the Central Eureka Mine.

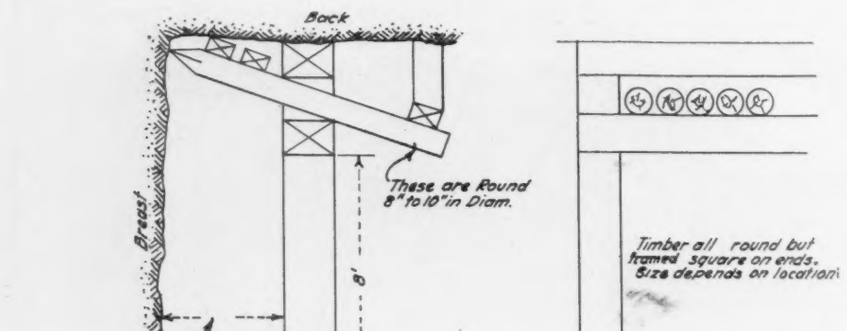
The ground in the stopes is very heavy, and so as to prevent cave-ins the filling is kept close up behind the miners. In the stopes where clay gouge is being worked it is necessary to support the back by spiling, of the ordinary mine type, as shown in an accompanying diagram.

Numerous air-driven stopers, "Jackhamers", and drifters—depending upon the character of work to be done—are in service underground. For example, CC-11 stopers, which are dry machines, are employed in the stopes where the ground is wet; CC110-W3 stopers, wet machines, serve to drive raises; BCR-430 "Jackhamers" are used for sinking: and drifters of different sizes help to get out the ore-bearing rock. The ore is well cracked and broken up, so that no block-holing is required. The steels used in connection with these pneumatic tools vary, as follows: 1¼-inch, hollow, round, lugged steels for the drifters; 1-inch, hollow, quarter, octagon steels for the wet stopers; ⅞-inch, solid, quarter, octagon steels for the dry stopers; and ⅞-inch, hollow, octagon steels for the "Jackhamers."

The ore is drawn from the stopes through chutes, and is thence trammed to the shaft in 16-cubic-foot end-dump cars running on 18-inch gage track laid on a grade of ¾ inch to 16 feet. There are loading pockets at all stations each having a capacity of about 150 tons. At the present time hoisting is being done principally from the 4,500- and the 4,700-foot levels. The skips dump automatically at the surface; and after the oversize ore has passed over a grizzly it is reduced to 2-inch size by a Blake type jaw crusher. With that done, it is hand trammed in 2-ton cars for a distance of 250 feet to the mill.

From the mill bins the ore is fed by means of Challenge suspended-type feeders to 40 stamps, arranged in eight batteries of the usual five each. Both inside and out, amalgamation is used in reclaiming the precious metal—the amalgamation plates being 16 feet long and 5 feet wide. The mortars are of the single-discharge type. The ore is next treated on 6-foot Frue vanners; and there are two vanners to each battery of stamps. About 2 per cent of the mill feed is recovered in the form of sulphide, which runs in value from $60 to $100 a ton. The product is packed in bags and sent for further treatment to the Amador Metals Reduction Company, a local concern that operates a custom's cyanide mill. The tailings go to a storage pond, about a mile away. This is necessary, as it is forbidden by law to discharge mill tailings into

1—Amalgamation plates and stamps in the mill. 2—Main hoist of Central Eureka Shaft, with compressor in the foreground. 3—Blacksmith shop equipped with a No. 50 "Leyner" sharpener and an I-R pedestal type shank-and-bit punch. 4—Timber-framing shop. Large timber in background is for shaft repair. 5—Compressor house at the Central Eureka Mine.


Back
These are Round 8" to 10" in Diam.
Breast
8'
Timber all round but framed square on ends. Size depends on location
Interval is kept at 2' or Less in heavy ground and a light blast used
Fill
Side View
Front View

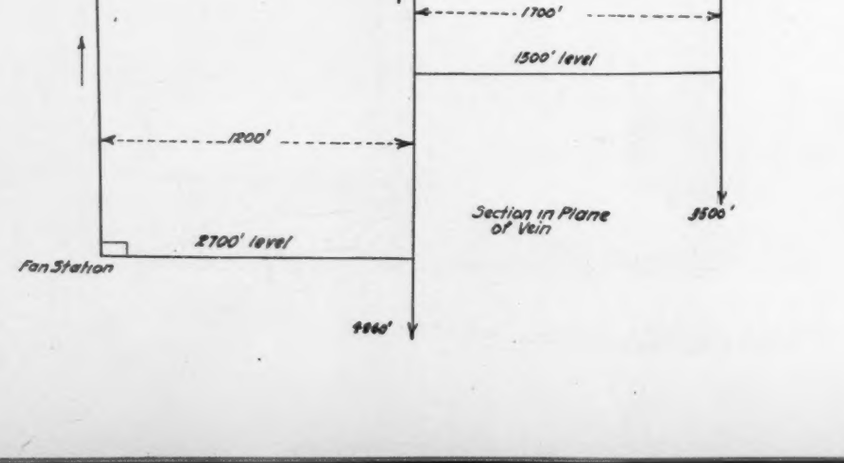
Stope spiling as used in the Central Eureka Mine.

any stream flowing into San Francisco Bay. The tailings can be reclaimed at any time should it be decided that they are worth handling. The amalgam is retorted and the bullion melted at the property—the gold bars being shipped to the Selby smelter of the American Smelting & Refining Company.

The Central Eureka Mine hoists about 160 tons of ore daily, and produces gold to the value of $500,000 and more annually. For example, during the year ending March 31, 1927, a total of 46,756 tons of ore was mined and $551,108.21 worth of gold was produced with the mill running 293 days on a 40-stamp basis. Of this sum, $432,679.59 was in bullion and $118,428.62 in concentrates. During the same period the workings were extended 3,723 feet, consisting of 2,473 feet of drift; 732 feet of crosscut; 408 feet of raise; and 110 feet of shaft. The gold recovery per ton of ore milled was $11.789, while the tailings yielded $1.165 of gold per ton. This may seem a high value for tailings, but is explained by the fact that the ore is difficult to cyanide because it contains a large amount of graphitic carbon.

Three Ingersoll-Rand, Type 10, belt-driven compressors furnish air at the mine. Two of these units, located at the Central Eureka Shaft, have piston displacements of 599 and 888 cubic feet, respectively. The third Ingersoll-Rand machine, which has a piston displacement of 1,190 cubic feet, is at the Old Eureka Shaft, where there is also a compressor of another make with a capacity of 550 cubic feet of free air per minute. The air is supplied at a pressure of 100 pounds per square inch.

There is a 4-inch air line in the Central Eureka Shaft, a 6-inch air line in the Old Eureka Shaft, and a 4-inch connecting line—1,700 feet long—on the 1,500-foot level. Large receivers are provided at the surface at each of the shafts. Besides serving to operate the pneumatic tools previously mentioned, compressed air is used to drive some of the pumps and a 25-hp., 2-cylinder, single-drum hoist on the 4,700-foot level of the Central Eureka Shaft. This hoist is used in sinking.

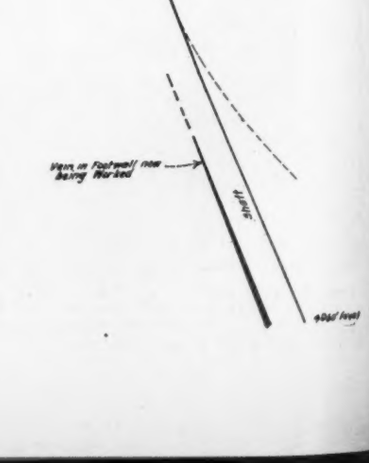


The Central Eureka Shaft has just been sunk 152 feet deeper to open up a new level—the 4,850-foot level. One hundred and ten feet of shaft is needed beneath the lowermost station for ore and waste bins, for a safety bulkhead, and for a sump chamber beneath the bulkhead. The bulkhead is solidly built of 14x14-inch Oregon pine across the hoist compartments, and also serves as a floor for a bin designed to catch rock spilling down the shaft. This rock is drawn off from time to time through a chute into the ladder compartment, whence it is raised by an underground hoist and dumped into bins beneath the station above. Working beneath the bulkhead, shaft sinking can proceed without interfering with other mining operations.

At the Central Eureka Shaft the main hoist is of the double-drum, geared type, and is operated by Westinghouse motors. It was built for Pelton-wheel drive by the Risdon Iron Works, and later converted to steam drive. Now, as just stated, electricity is the motive medium. This change to steam and then to electric power is typical of the entire district, as most of the hoists and other machinery on the Mother Lode were originally operated by Pelton wheels.

Power for the mine is obtained from the Pacific Gas & Electric Company. Current is received at the plant at 17,000 volts and is stepped down to 440 volts—the rated voltage. As a matter of fact it is somewhat higher, what might be called a compromise voltage that permits running the numerous 500-volt motors on the property as well as some new motors of 400 volts.

Ventilation of the workings is achieved by two blowers set in a concrete station on the 2,700-foot level of the South Eureka Shaft. The fans are of the Sirocco type, made by the American Blower Company. One of



them, which is direct connected to a 50-hp. motor, is an upcast fan that operates most of the time. The other, direct connected to a 25-hp. motor, is an emergency fan that serves to reverse the air currents in case of necessity. Both are run at 1,750 revolutions per minute. The South Eureka Shaft constitutes the upcast shaft, and the Central Eureka and the Old Eureka the downcast shafts. All drifts are fitted with draft doors; and dead ends are aired by the aid of large-diameter ventilating pipes with air jets in them. The temperature underground varies from 78 to 82° F. However, because of the effective system of ventilation, the working conditions are not uncomfortable. And now we come to the pumping equipment.

The Old Eureka has its own pumping system, while the water from the Central Eureka is raised to the 2,700-foot level of the South Eureka, whence it is pumped to the surface. Along the Mother Lode, most of the water comes into the mines between the surface and the 2,000-foot level. At the Old Eureka Shaft there are three Cameron centrifugal pumps operating in series. These are driven by 100-hp. motors running at 1,750 revolutions per minute. The first of them is on the 500-foot level, and is a No. 4 three-stage with a capacity of 500 gallons a minute pumping to the surface against a head of 500 feet. The next one, of the same size, is on the 1,000 foot level, while the third is stationed on the 1,700-foot level. This is a No. 5, capable of handling 375 gallons of water a minute against a head of 700 feet. All three of these pumps are automatically stopped and started by floats in the sump. The water column is 8 inches in diameter throughout.

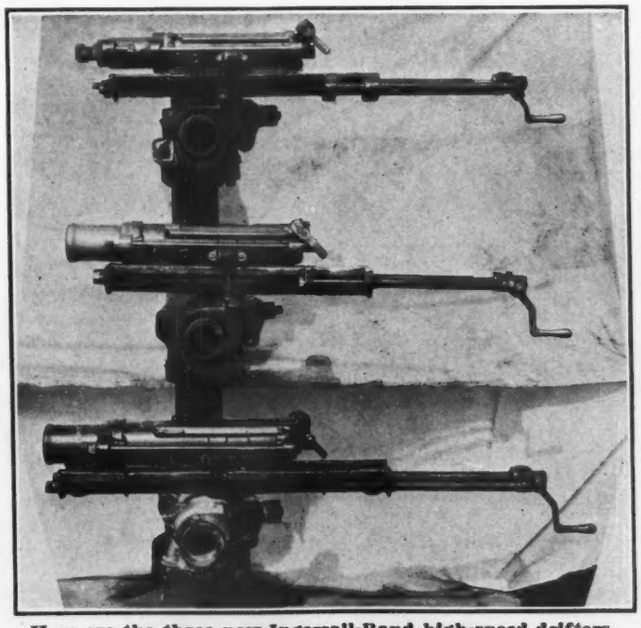
Nine small Cameron pumps constitute the pumping equipment at the Central Eureka. All these pumps are of the outside-packed, horizontal, plunger type; are operated by compressed air; and pump to a sump on the 2,700-foot level at the South Eureka Shaft. Seven of them are usually in service at a time; and the head under which they work varies with their station in the mine.

On the 2,000-foot level of the South Eureka Shaft are two outside-packed, triplex, horizontal, plunger pumps handling 250 and 200 gallons of water a minute, respectively, against a 2,000-foot head. One is a Dow and the other a Dean: and one acts as a spare. In the same shaft, but on the 2,700-foot level, are two vertical, triplex, plunger pumps of the Dean type. They are electrically driven: operate in series; have a combined capacity of 200 gallons a minute; and pump from the 2,700 to the 2,000-foot level.

Both Mr. Howe and Mr. James Spiers, his assistant, are great believers in what they refer to as the value of environment, and this explains why the mine and its surroundings are kept exceptionally neat and attractive. A force of 200 men is employed on two 8-hour shifts—one going on at 6:30 a.m., and the other at 6:30 p.m. And for the comfort of the workers fresh water is piped into the mine—drinking fountains being provided at every station. Among the camp buildings is a well-equipped emergency hospital; and the Central Mine Rescue Station, which serves the entire district, is on the premises. There are neither boarding houses nor bunk houses on the property, and no stores are sold there; but the mine has comfortable change houses. The hot-water supply for these comes from a large boiler equipped with a Dutch oven fired with refuse wood and sawdust from the mine. Board and lodging can be obtained by the men in Sutter Creek at $33 a month—the miners' pay averaging $4.50 a day.

Herbert Photos, Inc.

The Fire Department of the City of Los Angeles, Calif., adopted a type of oxygen helmet which enables the wearer to breathe normally under a wide range of conditions. The helmets were accepted by the department only after they had been subjected to rigorous tests under actual fire conditions and after submergence in a swimming tank.



Here are the three new Ingersoll-Rand high-speed drifters recently placed on the market. They are shown mounted on the same column; and it is easy to see how virtually alike they are in construction.

NEW LINE OF HIGH-SPEED DRIFTER DRILLS

THE Ingersoll-Rand Company, of New York City, has recently announced a new line of air-driven drills of the drifter type. These drills, three in number, are all of the same general construction, differing only in size.

The largest, the S-70, weighs 185 pounds. This type is recommended for heavy duty in hard rock and for deep holes. It is especially suited for tunnel work, for large mine headings, and in both dimension- and crushed-stone quarries. The next in size, the 138-pound N-75 machine, is adapted for the general run of drilling around a mine. Its power and speed enable it to do work that formerly required the use of drifters from 20 to 40 pounds heavier. The third, the L-74, is recommended for medium-soft ground and for close-quarter or any other operations calling for a light-weight drill. This machine weighs 110 pounds, and is powerful withal.

According to the manufacturer, the outstanding features of the new drifter drills are: straight lines; low center of gravity; minimum of vibration; long guides, giving longer life; amply proportioned chuck parts; new I-R valve; and high drilling speed. Full details of these machines are contained in a folder which may be obtained free from the Ingersoll-Rand Company.

Great Elevated Tank Supplies Water To City of Royal Oak

By THE STAFF

THE City of Royal Oak, Mich., has lately amplified its water-supply system by constructing an exceptionally high tower for the purpose of obtaining a head that will insure satisfactory distribution for all purposes. What has been done in the case of Royal Oak is part of a general plan to provide water to Detroit and the vicinity through one extensive system in which the various outlying districts of large demand are supplied through the medium of elevated tanks.

We are indebted to Mr. E. M. Shafter, city engineer, for the following particulars. Owing to the fact that much of the water supply of Royal Oak has been derived from underground sources which have proved uncertain from time to time, and owing to the rapid growth of this community, it became necessary to make arrangements with Detroit to supply water to the district. According to the water-works plan of Detroit, the metropolitan area—lying to the north as far as the Fourteen Mile Road and from Monnier Road on the west to John Road on the east—would be served by a 48-inch steel main leading from the Eight Mile Road, at Livernois Avenue, to a 1,500,000-gallon elevated tank located on the west side of Woodward Avenue just north of the Ten Mile Road. This scheme also included the construction of a booster station, in the vicinity of the Eight Mile Road, to lift the water into the elevated tank. In order to fill the tank it would be necessary to pump against a 100-foot head.

For several years an effort was made among the various cities and villages included in this district to get together and work out some plan of financing such a water system; but, for various reasons, no agreement could be reached, and it finally fell upon the shoulders of the City of Royal Oak to handle the proposition alone. A bond issue, amounting to $500,000, was proposed, and the people of the community approved it by a large majority. Under the guidance of the Detroit Water Board engineers, plans for the 48-inch steel water main and its appurtenances, as well as for the booster station, were prepared in the local office; and the construction of the system is now well underway.

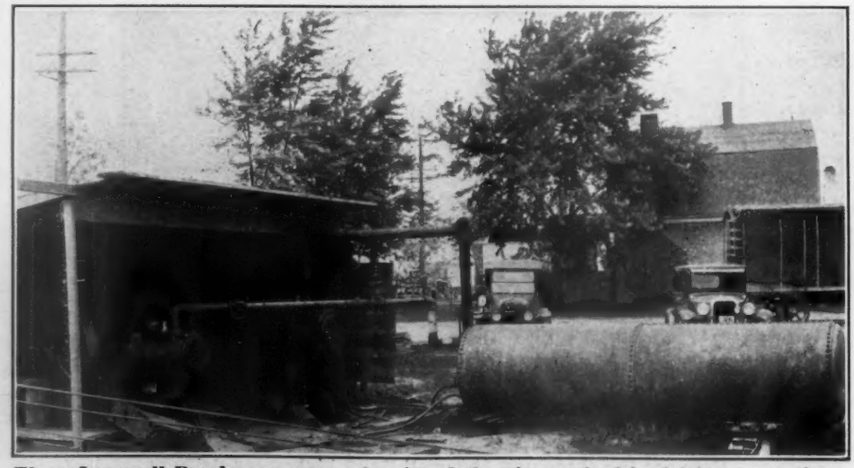
The contract for the construction of the 48-inch steel water main was awarded to the R. D. Baker Company of Royal Oak. This line has been installed and tested to the satisfaction of the Detroit Water Board engineers; and the cleaning up of the entire job has recently been accomplished. The total cost of the steel main in place has amounted to approximately $230,000.

Assembling the 1,500,000 gallon Horton tank that now supplies water to the City of Royal Oak.

The contract for the construction of the 1,500,000-gallon elevated tank was awarded to the Chicago Bridge & Iron Works for a lump sum of $93,050. The foundation for the tank was built by the N. A. Starr Company at a cost of $9,906. The tank is now completed, and the combined outlay for the foundation and the tank, with incidental inspection and engineering fees, has been approximately $114,000.

The tank is said to contain more steelwork than any other water tank, and this is due, in part, to the fact that the high water level is 150 feet above the concrete foundation. There are other tanks of greater capacity, but none of them is mounted at so great a height. The tank, itself, is 70 feet in diameter, and from the bottom of the tank to the peak of the roof is also 70 feet. In assembling the tank it has been necessary to drive a total of 52,500 rivets, ranging in sizes from 7/16 inch to 1¼ inches. The compressed air required to operate the riveting hammers, reamers, and the calking machine was furnished by two belt-driven Ingersoll-Rand compressors—the larger machine, a 12x10-inch unit, proving generally capable of providing ample air at periods of maximum demand. The foreman on the job, Abe S. Miller, has stated: "Have operated this size compressor on three large jobs without the loss of any time because of a shortage of air."

Horton steel tanks of this type are not a novelty. It seems that the Chicago Bridge & Iron Works, two years ago, erected a 2,000,000-gallon elevated tank at Charleston, S. C.; and the tank lately finished for the City of Royal Oak is believed to be the next largest in this country. During the last few years, there has been a steady increase in the use of large elevated tanks in water-works systems; and the Chicago Bridge & Iron Works has built several of 1,000,000 gallons capacity.



These Ingersoll-Rand compressors furnished the air required in driving more than 52,000 rivets and in doing other work in connection with the great elevated water tank.

Idaho, so *Hydraulic Engineering* announces, has planned a new and big reclamation and irrigation scheme that would bring under cultivation thousands of acres of fine land on what is known as the Boise Mountain Home project. The proposed undertaking would entail an outlay of $40,000,000, and call for the construction of a water tunnel, 25 miles long, to be driven through the mountains. It would also necessitate the building of a high dam—one of the highest in the world.

Sacambaya Treasure Hunt

Gold Hoard Hidden in Old Peru By Priests 150 Years Ago

Now Being Sought With Modern Machinery

By J. R. SHOTTON

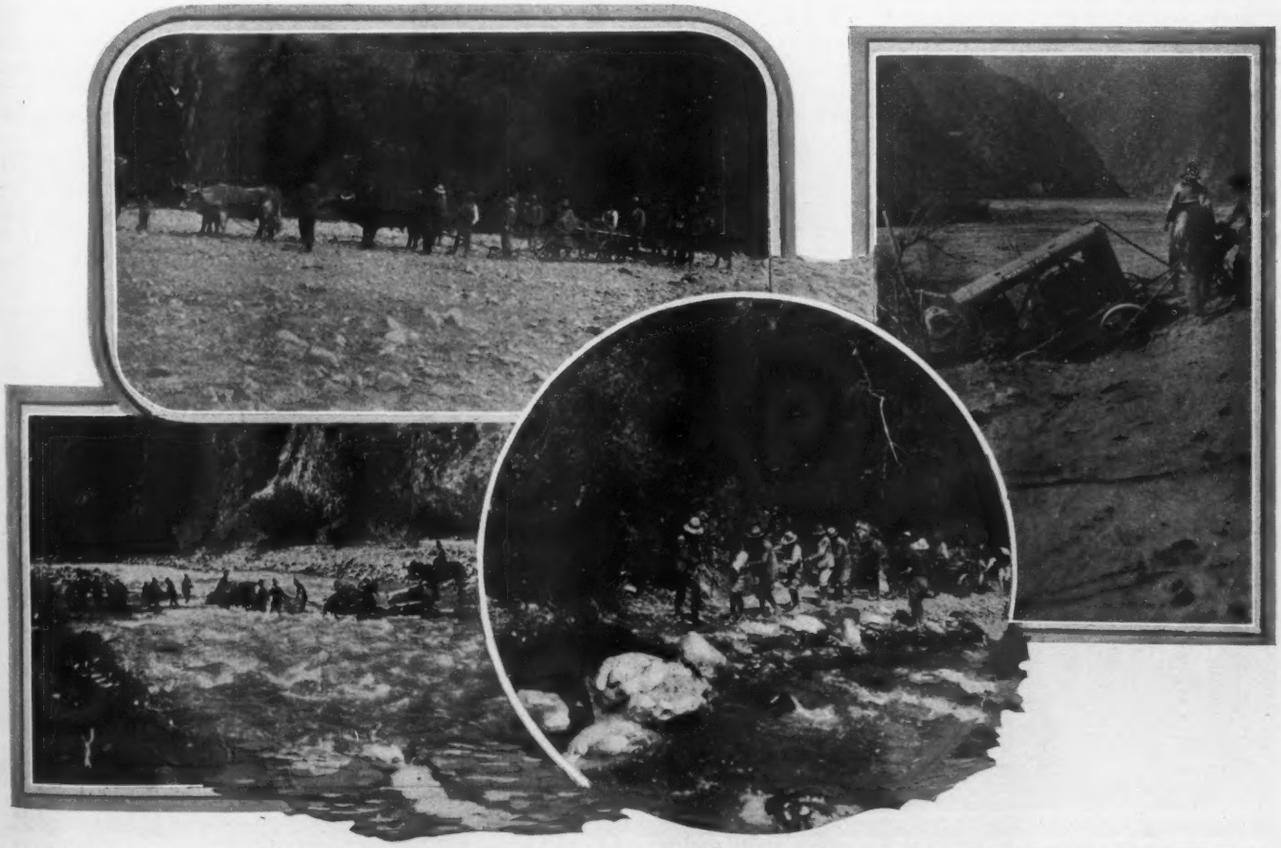
FICTION writers have often made a treasure hunt the theme of their stories; and, though these may or may not be interesting, it is a little beyond the imagination of the average person to realize that an actual treasure hunt, on a big and modern scale, is in progress at the present time. Before describing the work which is being carried out now, it would be well to start at the beginning and to give a brief history of the treasure.

The story is about the Jesuit mines in upper Peru, now called Bolivia, and of the ultimate deportation of the Jesuits in 1778. Shortly after Pizarro and his conquistadores had established themselves in the rich country of the Incas, Jesuit missionaries followed. They soon discovered that the land of their adoption was richly endowed with valuable minerals, to the extraction of which they subsequently turned most of their attention. The center of their activities was at the junction of the Khato and Ayopaya rivers, which form the Sacambaya River. Here they built a monastery, on one side, and a fortress—commanding every point within sight—on the other. They toiled undisturbed for more than a century, exporting their gold to Europe without paying a 20 per cent royalty due to the Spanish Crown. This question, however, became acute; and as the Jesuits persistently refused to pay the royalty they were completely blockaded in the interior. By that time, 1767, the authorities wished to deport them, but did not succeed in doing so until 1778, owing to strong ecclesiastical influences. The Jesuits kept the mines working to the end, hoping that deportation orders would be cancelled; but, when they finally had to go, they decided to hide their accumulated gold so as not to have it confiscated. Apparently they had foreseen the possibility of leaving, and had plenty of time to hide their treasure effectually, for to this date it has eluded all searchers and still remains undiscovered.

Father Gregorio San Roman—one of the Jesuits deported from the Sacambaya—on his way out of the country, gave to his brother, then Prefect of Callao, Peru, a description of the hiding place. The latter made notes of the verbal description; and this document was handed down in the family. The value of the hoarded gold is said to be the equivalent of £12,000,000.

In the meantime, representatives of the government and of various private enterprises were sent to search for the hidden treasure, but all met with failure. The document just mentioned only came to light in 1905, when Corina San Roman, a direct descendent of the deported Jesuit, asked Cecil Prodgers to undertake to unearth the treasure. Prodgers organized three small expeditions—in 1905, 1906, and 1907, respectively; but they, too, proved unsuccessful. The main reason for this was that he did not interpret the document correctly: he operated only on one spot instead of surveying the surrounding locality for traces of artificial workings.

In 1920, Prodgers had to abandon his efforts for health reasons, and turned all his information over to Dr. Edgar Sanders, the leader of the present expedition. Doctor Sanders was unable to take up the search until 1925, when he organized a small ex-



Top, left—One of the portables reaching Sacambaya. Heap. Bottom, left—Crossing the Khato River. Right—Dragging a portable uphill from the river to the Square Stone Circle—Approaching Sacambaya along the shore of the Khato River.

Left—So-called motor road between Inquisivi and Quime. Right—Getting one of the portables by an overhanging rock on a ticklish section of the road between Quime and Quebrada.

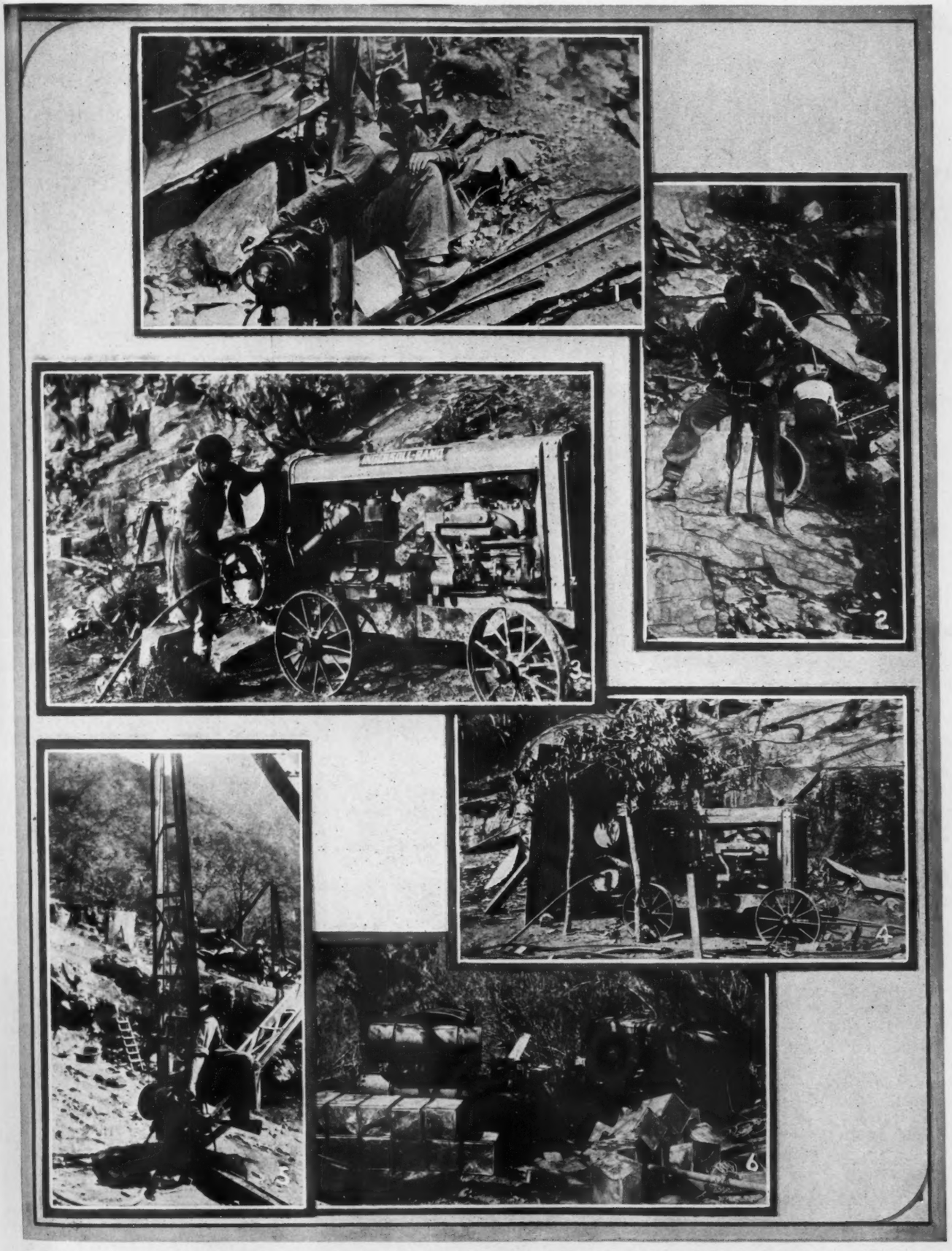
pedition. This was followed by another in 1926. He spent most of his time surveying the district in an endeavor to interpret the document, which was correct in its essential points but somewhat incomprehensible in its details. The explanation for this is presumed to be that in the short time in which the deported Jesuit had to tell his story, the brother—not knowing the district or anything about the hiding place—confused the details when he proceeded to put them on paper.

In 1926, after considerable exploring, Doctor Sanders discovered a huge artificial stone structure, which he named the "Square Stone Heap". He also discovered, some little distance away, a filled-in tunnel, which is probably one of the entrances to the treasure chambers. After a few days digging in the tunnel, a silver crucifix and a parchment were found—the parchment containing a warning not to proceed farther with the search. The few natives he had with him refused to go on; and as the rainy season was approaching Doctor Sanders decided to abandon operations for that year; to return to Europe; and to organize an expedition on a big scale.

January, 1928, saw the formation of the Sacambaya Exploration Company, Ltd.; and on March 1, a party of 22 sailed from Liverpool for Arica armed with the most modern equipment necessary to attack the treasure chambers. The equipment includes four 5½x5-inch portable compressors; four pneumatic hoists; three "Jackhamers", one paving breaker, six trench diggers, and two clay diggers—all air operated; one Cameron prospector's pump; one Gwynne hydraulic mining outfit, complete; another Gwynne high-pressure pump, for hydraulic mining purposes and driven by a Waukesha motor, which serves the twofold duty of alternately driving the pump and a circular saw; two 6-wheel Morris trucks; two gasoline winches; two electric lighting outfits; six steel derricks; and many other useful items of camp and general equipment.

From Arica to La Paz, a special train was chartered; and the same was done in the run from La Paz to Eucalyptus, the railhead station. It was necessary for the whole expedition to get a "breather" at La Paz, as

Snapshots showing difficulties encountered in handling the portable compressors on the steep slopes between Inquisivi and the Khato river bed.



1—Utility hoist operating a derrick on the south side of the Square Stone Heap. 2—Block-holing boulders with a BCR "Jack-hamer". 3—Portable compressor on the north side of the Square Stone Heap. 4—Awning of branches shading fuel tank to minimize evaporation on a hot day. 5—Another derrick equipped with an air-driven utility hoist. 6—Two of the portables that have furnished operating air in attacking the Square Stone Heap.

Left—Crossing the first river on the first day out from Quime.

Right—Crossing the Khato River upon a heavily taxed bridge of logs.

Oval—The toilsome job of dragging a portable uphill to the Square Stone Heap.

the overnight climb from sea level to a height of 14,500 feet, in crossing the Andes, had upset the hardiest. Arica was reached on March 31, and six days later the party arrived at Eucalyptus, where all the equipment was unloaded. The journey to Pongo, 60 miles away, offered no difficulties, as the motor road thence is one of the best in this part of the world. It is probably also the highest in the world, climbing to over 16,500 feet at Tres Cruces, and averaging an altitude of about 14,000 feet. The compressors were transported on the Morris trucks. The stretch onward from Pongo to Sacambaya, however, was one that presented heartbreaking obstacles. The rainy season, which should normally have been at an end about the middle of March, continued until the end of April. Also, it was an exceptionally heavy one; and the existing meager trail was washed away at many places. A landslide of about 250 yards severed the main road. Small bridges had been carried away; and boulders of large dimensions littered the road and blocked it. Some of the boulders were loose and had apparently been washed down from adjacent hillsides. Those were easy to negotiate, but the real difficulty consisted of those portions of the boulders that the torrents had left protruding.

After a rapid survey of the Pongo-Sacambaya road, it was decided to abandon the idea of taking the trucks all the way, as this would have meant remaking most of the road and, besides, would not have allowed us enough time to do our proposed work during the dry season. The compressors were stripped to the utmost—that is, frame, compressor, and engine bare. The hydraulic mining outfit, being light and also on a spring chassis, was taken complete. The remainder of the equipment was stripped and packed into convenient loads, not exceeding 300 pounds, so that they could be carried by mules. Each mule load—including equipment, stores, and supplies—weighed approximately 400 pounds. Considering the ruggedness of the path, no further comment is needed. The compressor party, however, deserves special mention, as the success of the expedition rested on their shoulders. Their protracted journey of 42 miles took 5 weeks and 5½ days. The following distance and time table will make it easier to realize what they had to contend with:

	Distance Miles	Time Days
Pongo to Quime	4	1
Quime to Quebrada	6	4½
Quebrada to top of first *questa*	¾	3½
Top of first *questa* to top of second *questa*	1	4
Top of second *questa* to Inquisivi	13	6
Inquisivi to Khato river bed	2½	8
Khato river bed to Sacambaya	14¾	13½
Total	42	40½

Three days after the Pongo-Quime road was reopened to motor traffic, our lorries made four journeys over it; and we decided to tow the first compressor down over this very difficult 4-mile stretch. We started off very cautiously, expecting the small wheel lock of the compressor to give us trouble at corners. But it was soon discovered that they towed amazingly well. The nature of the road can be imagined when one learns that the lorries had to reverse at at least a dozen corners, and reverse two or three times at fully half of them. The total descent was 2,000 feet. After getting all the compressors to Quime without incident, it was possible to tow them for another three-quarter mile on the road to Inquisivi. There our lorries had to turn back; and the remainder of the journey was faced without their aid.

The trekking party consisted of five white men and twenty Indians, and the equipment included the four compressors, the hydraulic mining outfit on spring chassis and rubber tires, a 3-inch fourfold purchase, a handy billy, 300 feet of 3-inch Manila rope, a specially made towing line with shoulder loops, a ½-inch chain sling, two 15-foot and two 7-foot I beams—mounted on one of the compressors which was fitted with a special wooden support—and picks, shovels, crowbars, and sledge hammers.

A start was made at 6:30 on the morning of May 6. The first mile and a half was down hill and fairly steep. Owing to inexperience, no chain brake was used. We got on very fast, and were lucky to have no accidents. A small river was crossed, and a rope and tackle utilized on a steep incline immediately following it. This astonished the Indians, who could not understand how the compressor could be moved forward by pulling a rope toward it. Then came a rough but fairly level stretch. At a sharp corner in the road, alongside and immediately above the river, there was a solid rock overhang, and there the track had been almost washed away by the stream. A temporary bridge was built with the I beams—the compressor wheels running inside

the channels. Shortly after that, a 250-yard landslide had to be tackled; and the compressors all but went over on seven different occasions. The only damage sustained so far happened when one compressor ran away on a 1 in 3 slope, resulting in a buckled drawbar. By that time, however, we had learned to use the chain sling as a brake on one of the wheels.

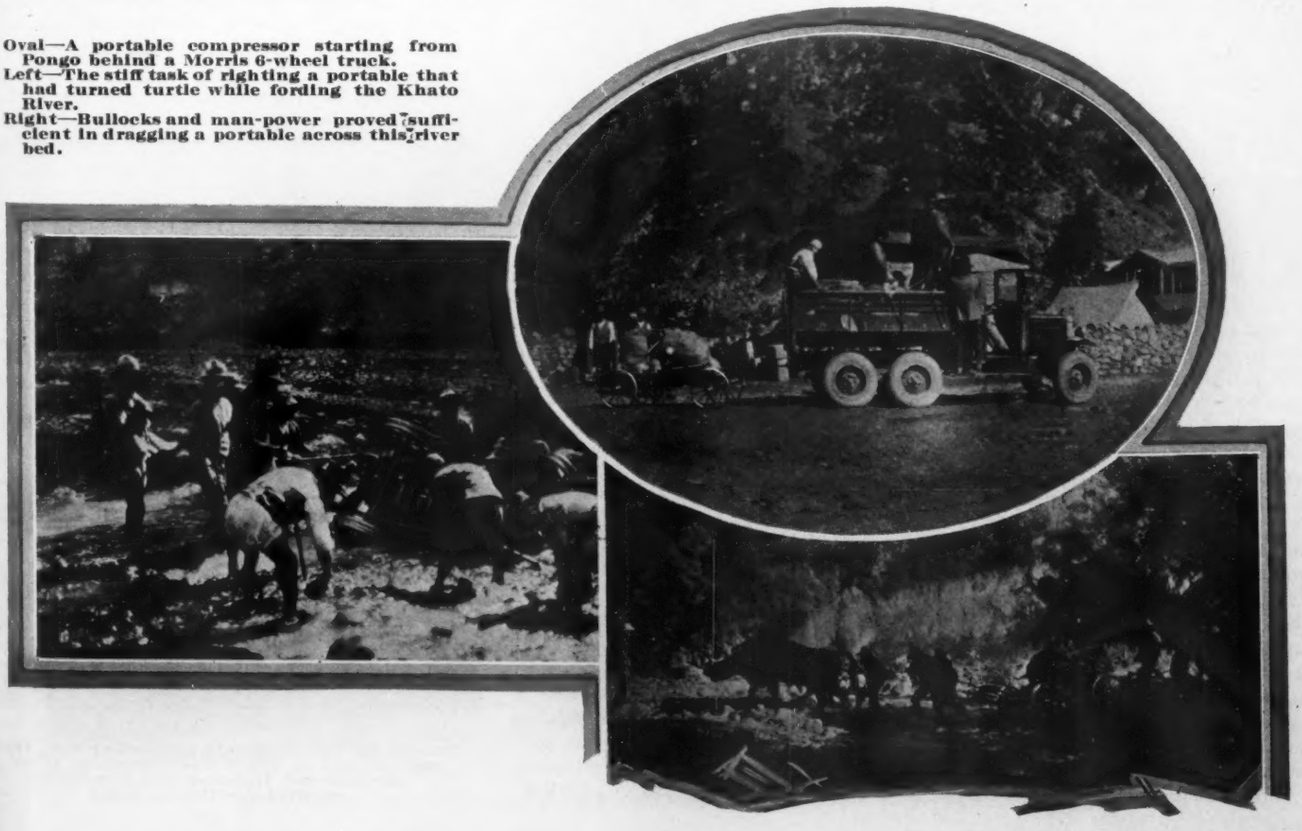
The first *questa* consisted of a rise of 800 feet in steep zigzags, varying in gradient between 1 in 4 and 1 in 2; and a rope and tackle had to be employed there all the way. Anchors were built with I beams by burying the beams in trenches cut for the purpose across the trail. Sometimes trees and rocks favorably located served the same end. Each compressor had to be crowbarred around every corner, as they were all too sharp; and at the top of the *questa* there were four sharp turns between high banks of jagged rocks. There the machines had to be lifted bodily to make the grade.

After about a mile of comparatively easy going, the second *questa* was reached. This was much the same as the one just described, only longer. At the summit, the trail was supposed to connect with a projected "motor road" from Inquisivi to Quime, a stretch dropping gradually along the contours of the hills. As a matter of fact, this so-called motor road was worse than the mule trail on which the compressors had been towed. In most places it was less than 4 feet wide, and very insecure. In building the road, the Indian laborers had dumped hundreds of tons of rock on to the path below, with the result that the weight of the superposed mass sent a portion of the trail into the valley, 2,000 feet below. At this point a zigzag path had to be cut—the slope of the hill being almost vertical and the slope of the track across it about 40°. Anchors were useless; and it was hard to excavate a wide enough roadway without causing a landslide from above. The compressors had to be reversed at each corner.

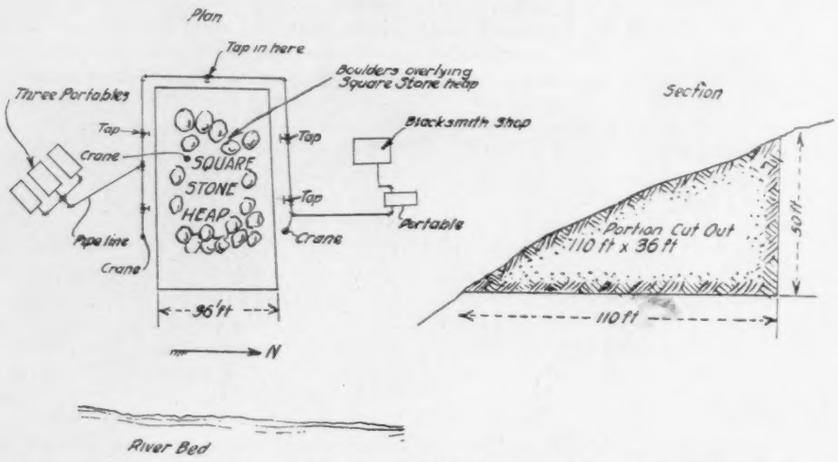
The first part of the motor road included several ½-mile stretches of 1-foot-wide excavations, so it was decided to follow the trail for six miles to a point where it crosses the motor road again. Three successive ravines had to be bridged; and several long and difficult climbs had to be tackled. By this time, two oxen had been obtained, and these were found quite helpful in towing, in conjunction with the men, where gradients were not too steep. The remainder of the motor road was more or less passable for our purposes, although hopeless for any automobile, even a Baby Austin. On one side there was a drop of close on to 3,000 feet, and on the other an almost vertical wall of rock.

The first compressor was hauled into Inquisivi by one white man, four Indians, and two oxen; and the time taken to cover the last six miles was 2 hours and 50 minutes. Steering the compressors always presented difficulties—the best results apparently being obtained by attaching two ropes to the drawbar ring and by having two steersmen. The use of a bar, lashed either laterally or longitudinally, was far too dangerous, as the wheels and drawbar were thrown violently about by the rocks that littered the entire way. The second and the third compressors were brought in similarly the following day. The fourth unit was then also due at Inquisivi; but, unfortunately, one of the Indian steersmen had gone to sleep and allowed a large stone to deflect one of the front wheels over the edge of the road. This had happened before, but with no bad results other than a lot of trouble. It had never occurred with the oxen attached; and those noble animals, of course, pulled the rear wheel over the edge, with the consequence that the compressor went over, taking bullocks and men with it. After turning over completely, twice, the machine landed on its side, amongst some bushes, 30 feet beneath. Those bushes—the only ones in the neighborhood—alone prevented it from going down to the bottom of the valley, 3,000 feet below. Luckily, the remainder of the party was near at hand. Three men were hurt, but not seriously, and the bullocks escaped with scratches. In fact, the bullocks were so unperturbed that they were found lying beside the compressor nibbling the bushes. The team and the compressor went over at 4:40 p.m.; and by 5:55 the machine, undamaged, was back on the road.

The descent from Inquisivi to the Khato river bed, a drop of 3,000 feet in 2½ miles, took eight days. The first half was not steep, though winding and difficult. Three bridges had to be built, and a trail made almost the whole distance. The last 1,000-foot drop was the steepest, and there a trail was cut right down the hillside—the compressors being lowered almost bodily, with two men in front steering. At one place, fortunately the least abrupt, a compressor got out of control and turned a somersault, breaking



Oval—A portable compressor starting from Pongo behind a Morris 6-wheel truck.
Left—The stiff task of righting a portable that had turned turtle while fording the Khato River.
Right—Bullocks and man-power proved sufficient in dragging a portable across this river bed.



Sketch showing general arrangement of power equipment used in clearing away part of the Square Stone Heap.

the water-circulating pipe. This was the only serious injury sustained throughout the entire trip, and was successfully repaired.

The last stretch of 14¾ miles was along the Khato river bed. This is about 300 yards wide most of the way, excepting at one or two points where it narrows down to about 25 feet. During the dry season, the river winds from side to side, and has a different course every year. Twenty-seven crossings had to be made—the deepest being about 4 feet. The first compressor took six days to reach Sacambaya; the next two, two days each; and the fourth a day and a half. Four bullocks were used in the case of the last three machines. The last accident occurred with the last compressor, and on the last day. The steering gear locked during one of the river crossings; and, as the bullocks went on pulling, the machine capsized. With the exception of this unit, the compressors were erected and tested the day following their arrival. A few days later, as soon as the water-circulating pipe and the radiator had been repaired, the machine damaged in transit was also ready for service.

The main point of attack in quest of the treasure has been and still is the Square Stone Heap. Huge blocks of very hard quartzite covered the whole area, so three compressors were taken to the site. One has been operating a BCR "Jackhamer" and a DU hoist, secured to a steel derrick. This is as much as could be expected of a 5½x5-inch portable at an altitude of 6,000 feet. The second unit has been running a "Jackhamer" and a hoist, besides doing part-time service in supplying air to a sharpener and a forge; and the third compressor has made it possible to use still another hoist, a paving breaker, and two trench diggers. The fourth compressor was taken to the tunnel, where it operated two clay diggers and one hoist, which provided the motive power for a light railway mucking out the tunnel. Owing to a shortage of labor, however, activities at this point had to be abandoned temporarily, and all resources concentrated on the Square Stone Heap.

At the moment of writing, three compressors have been in daily use, ten hours a day, for eight weeks; and, despite the terrific buffeting to which they were subjected on their journey, the machines have required no further attention than that necessary in keeping them supplied with gasoline, oil, and water. In fact, the general comment is that it is amazing how the frames and the wheels stood the strain of the journey, and that it is even more remarkable how entirely automatic and reliable the compressors are in action.

The first five weeks work on the Square Stone Heap consisted mainly in drilling the huge quartzite blocks, blasting them, and removing them. Several interesting finds, such as pottery, a human jawbone, a stone gold-washing dish, and a stone wall, have been uncovered so far. Since then, we have been fortunate enough to strike bedrock, which happens to be shale, so the air-driven trench diggers have come into their own and are making good headway.

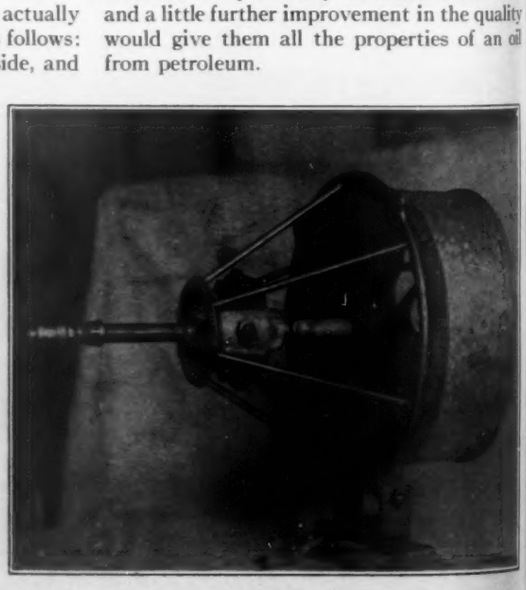
The layout and the equipment actually in use at the Square Stone Heap is as follows: Three portables are in line, side by side, and discharge into a common air line extending around three sides of the Square Stone Heap. The fourth portable is on the north side; and besides discharging into the common air line is independently connected to the forge and the sharpener. The machines at present are operating two "Jackhamers", one paving breaker, three hoists, four trench diggers, one sharpener, and one forge. It is proposed to erect another crane soon, so as to put to service an additional air hoist, as well as from two to four more trench diggers.

It is interesting to note, in connection with the three portables on the south side, that it has been found advisable to control them all from one auxiliary valve, which has been especially fitted for the purpose. By this method all three units get an equal chance at idling; and all cut in together when air demands make it necessary. The piping has been so arranged that any one or any two portables can be run and controlled by the one auxiliary valve, as there are occasions when the output of all three is not required.

The amount of material excavated during the last eight weeks, starting from the hour of the first blast when not even one crane had been erected, has averaged 80 cubic yards a day, or a total of about 3,900 cubic yards. Our first objective is somewhere in the neighborhood of 7,000 cubic yards which, at the present rate of progress, will be reached fairly soon. We hope, in the meantime, to find some further indications as to the whereabouts of the much sought after treasure.

DIESEL ENGINE RUN ON FUEL OIL FROM COAL

THE following account of the performance of a Diesel engine fed with fuel oil distilled from coal by the low-temperature process is suggestive of what may be expected in the near future. The engine in question, says J. S. Brown in the *Journal of the Royal Technical College*, Glasgow, was worked up to full load and normal jacket temperature with a standard petroleum oil, the fuel then being changed gradually to that under test. In one case excessive viscosity caused an air lock in the feed; but the performances with two others were entirely satisfactory when the engine was operating under full load. With only one of the oils was it possible to avoid pre-ignition when the engine was running at no load; and at no time could the engine be started without preheating the jackets. Two out of the three oils burned gave a small amount of deposit when mixed with Shell-Mex Diesel grade oil. According to Mr. Brown, the oils used were preferable to the creosote oils previously obtained from coal; and a little further improvement in the quality would give them all the properties of an oil from petroleum.



The prime mover of this ventilating fan, that can be used in mines and elsewhere, is an air-operated Ingersoll-Rand grinder adapted for the purpose.

Utah's Beet-Sugar Industry

The State Now Ranks Third in Our Production Of This Form of Sweetening

By A. S. TAYLOR

SUGAR is something more than mere sweetening—it plays a truly essential part in the American dietary.

According to eminent authorities, sugar is the primary source of substantially 13 per cent of the bodily energy obtained by us from the food we consume. On an average, each of us consumes 2 pounds of sugar weekly in our food, in our sweet drinks, and in the candies eaten the while. Statistics show that our fondness for sweet things is more highly developed and gratified than that of any other people. Our per capita consumption of sugar a century ago was only one-tenth of what it is in this present age of hustle and bustle. Possibly, our use of sugar may help to explain our exuberant energy—popularly termed "pep".

In the course of a year we use ordinarily close to 5,700,000 long tons of sugar, and of this amount approximately one-fourth is supplied from domestic sources. Of this sugar of domestic origin about four-fifths is produced from sugar beets—the remaining one-fifth being obtained from home-grown sugar cane. These figures are suggestive, because they give us an idea of the economic significance of the American beet-sugar industry which had its start 90 years ago, although that first attempt proved an unsuccessful one.

Utah ranks third among our sugar-beet states; and the growing of sugar beets contributes largely to the agricultural prosperity of that state. As far back as 1852 Mormon pioneers essayed to establish a beet-sugar industry in Utah. In those days certain European countries were foremost in the art; and, in order that they might have the best apparatus obtainable, the Mormons then bought machinery in France. The equipment

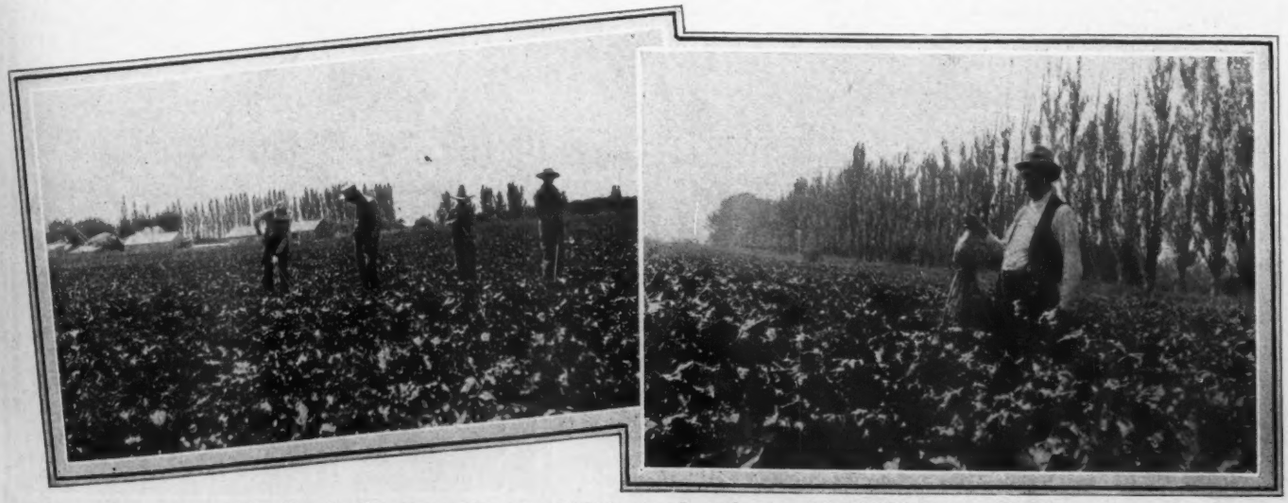
The steam plant of a beet-sugar mill is of prime importance.

reached Fort Leavenworth, Kans., by water, and from that point the long journey was completed overland. It is recorded that it took more than half a hundred ox teams quite four months to draw the machinery to its destination over the roads then available.

Even after that machinery was set up in Utah the venture failed—just why is not explained; but unsuccess may have been due in no small part to the lack of sufficient quantities of sugar beets to make the running of the mill profitable. That attempt showed, however, that the Mormons desired a supply of home-grown sugar adequate to meet their dietary requirements; and they were prepared to do what they could to create a beet-sugar industry in their "Chosen Land". The industry in Utah, as it exists now, may properly be said to date from 1891, when a mill was erected at Lehi large enough to handle daily 300 tons of sliced beets. By that time Mormon farmers had learned enough about the raising of sugar beets to warrant the establishment of that sugar plant.

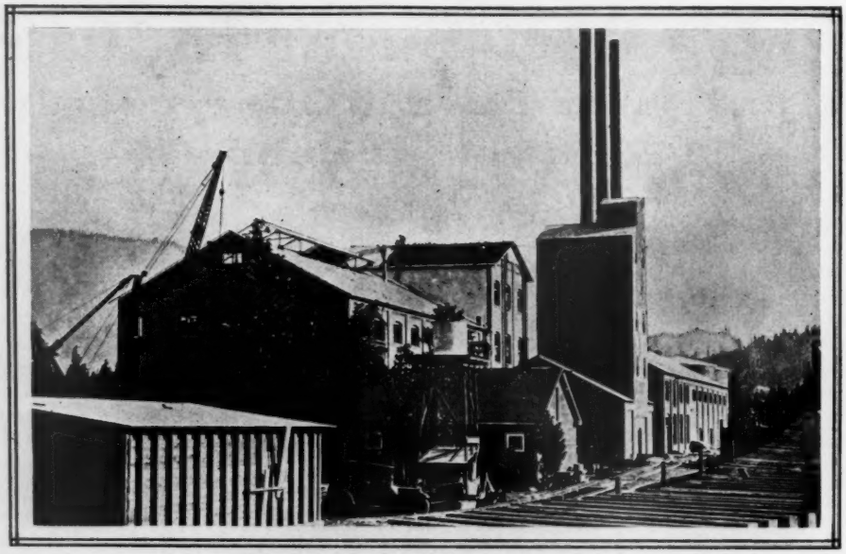
Today, Utah has eighteen beet-sugar mills, and all but two of them have been built since 1900 when favorable tariff laws offered the industry encouraging protection against foreign sugars. These mills are capable of handling every 24 hours a total of 12,500 tons of sliced beets in extracting their sugar content. This represents, on an average, a daily output of 4,250,000 pounds—that is, sugar sufficient to gratify the indulged palates of 2,125,000 Americans for a whole week. The operating period of these mills, called a "campaign", is 90 days during favorable years; and a little arithmetic will show that Utah's beet-sugar plants can produce annually fully 191,250 short tons of sugar. This figure varies from season to season and depends upon the sugar content of the beets, which may range from 13 per cent to nearly 20 per cent of the weight of the beets; and this sugar content, in its turn, is contingent upon the soil, the seed, the care given the crop at different important stages, and, last but by no means least, upon the weather.

Interesting as the agricultural phase of the topic undoubtedly is, we cannot dwell further upon it here. As far as the sugar mill is concerned, the principal thing is that



The farmlands of several parts of Utah grow luxuriant and profitable crops of beets.

the beets shall be so harvested and handled that they shall be bruised or otherwise damaged as little as possible between the time they are removed from the soil and their delivery at the mill. Bruised beets introduce impurities which lower the percentage of recoverable sugar. Furthermore, the beets must be harvested in an orderly fashion so that a constant supply will be available at each mill to permit operating the plant at capacity, or nearly so, during the full term of each campaign. This calls for careful organizing and complete cooperation between the farmers and the mills.



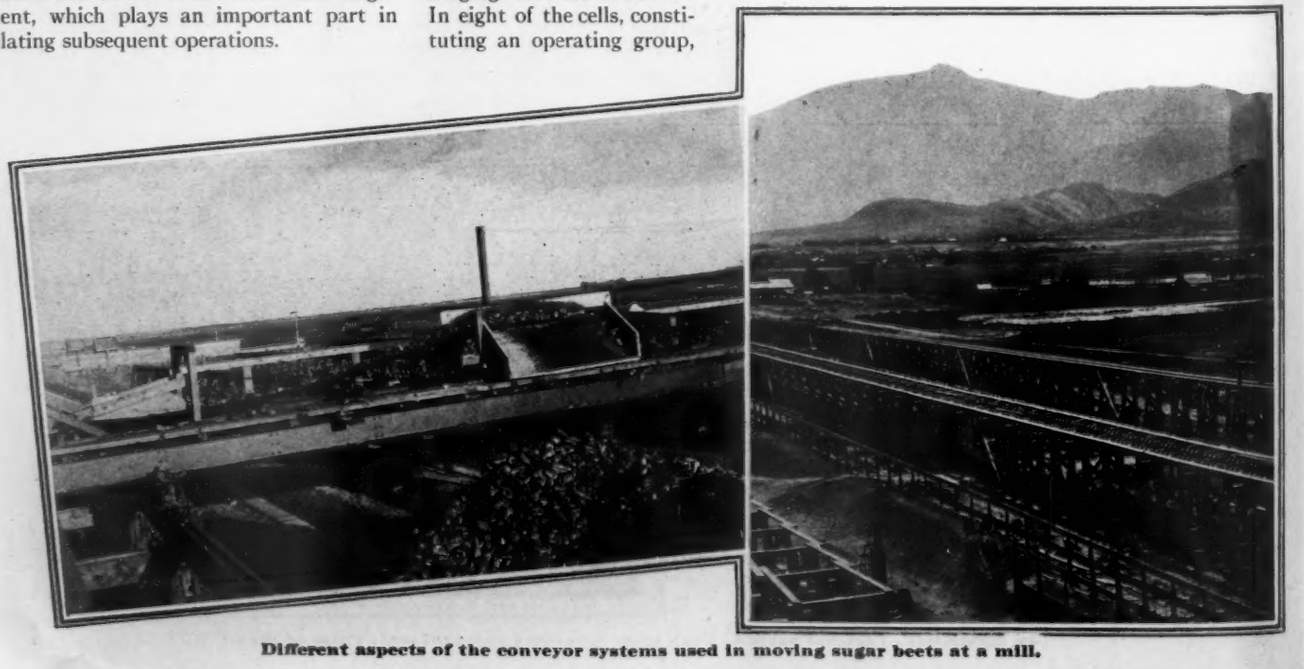
A Utah beet-sugar mill nearing completion.

Assuming that the beets have been harvested and delivered, let us see how the sugar is extracted in a typically up-to-date mill. As an example we shall take the West Jordan plant of the Utah-Idaho Sugar Company. The factory was erected in 1916, and is now capable of handling 750 tons of sliced beets in the course of 24 hours. From the storage sheds, which are capacious enough to hold sufficient beets to keep the mill supplied for a week or more, the beets are moved in water-filled flumes to the mill, where they are fed to washers equipped with mechanical agitators. The cleansed beets are then picked up by a bucket elevator and afterwards run through automatic scales that can handle them in 1,000-pound lots. In this way an exact check is maintained upon the quantity being processed at any time. Incidentally, the beets are tested to ascertain their sugar content, which plays an important part in regulating subsequent operations.

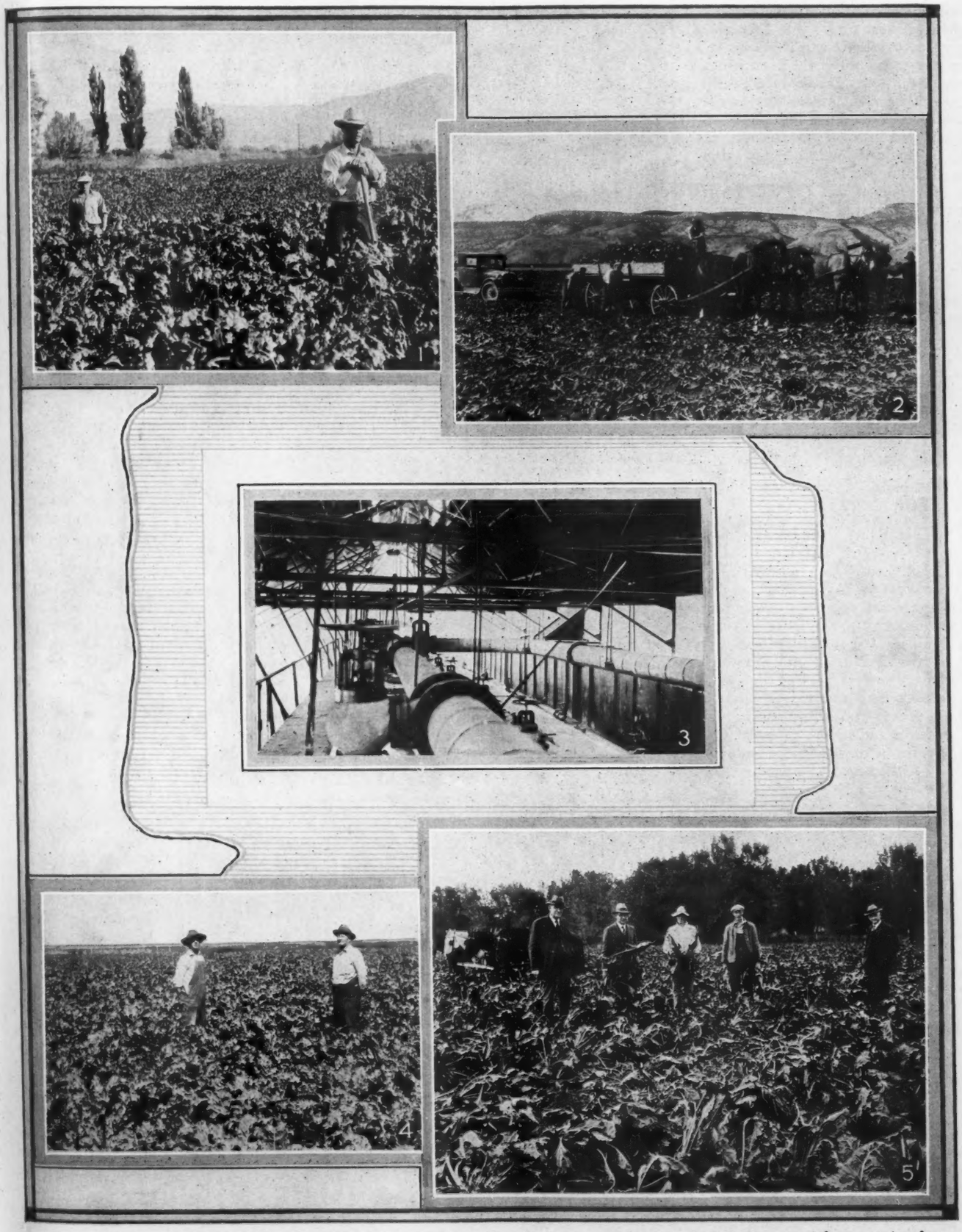
Having been washed or cleansed to the required degree, the beets are sliced by machinery to facilitate the extraction of their contained sugar. The cleaner the beets the more uniform the "chip"—as the sliced beets are called, and the fewer the bruised parts the higher the percentage of the resultant sugar. The reason for this is that when the cell structure is intact that formation prevents impurities from getting out of the beet structure and into the juice made up mostly of the water used in diffusing the sugar in the sliced beets. When the juice contains impurities, these check or reduce the formation of sugar crystals and increase proportionately the measure of molasses of far lower commercial value.

The diffusion process consists of placing the sliced beets in diffusion cells to which circulating water is admitted at a temperature ranging from 131 to 140° F. In eight of the cells, constituting an operating group, the temperature is raised to 185° F. by high-pressure steam injectors. The diffusion plant is made up of fourteen cells so interconnected that the discharge from the top of one cell enters at the bottom of the succeeding cell. Each cell contains about 3 tons of sliced beets; and eleven of the cells operate conjointly in the diffusion cycle—the cells being arranged to promote the circulation of the liquor which picks up more and more of the sugar content of the beets as it passes onward through the succeeding units of the battery. After the juice has completed the circuit, 125 cubic feet of the liquor is drawn off from the last or eleventh cell and is by-passed into a twelfth cell that has been stocked with a fresh charge of beets. When the juice leaves this cell its specific gravity indicates that the liquor holds in suspension anywhere from 12 to 14 per cent of sugar. Cell No. 1 of the circuit is cut out at this stage; the pulp in it—containing 0.2 per cent of sugar—is dumped; and the cell is washed out. Cell No. 2 becomes Cell No. 1 of the new cycle, and the freshly charged cell becomes Cell No. 11 of the battery. Clean hot water is admitted to the new head of the line.

The next problem is to evaporate the water of the "run juice" that has been drawn off so as to bring about the crystallization of the sugar in solution. The first step is to ascertain the purity of the raw juice. Let us suppose that the juice has a purity of 85 per cent

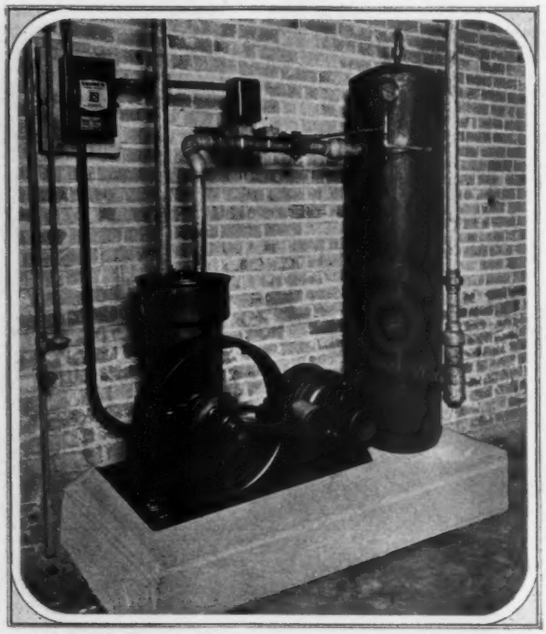


Different aspects of the conveyor systems used in moving sugar beets at a mill.



1 and 4—Fine examples of stands of sugar beets. 2—Harvesting the crop. 3—A sugar-beet factory contains an extensive arterial system made up of many sizes of piping. 5—A crop of sugar beets plowed up and ready for shipment to the factory.

sugar and 15 per cent of other matter or soluble impurities. Every pound of impurities will keep from 1½ to 2 pounds of sugar from crystallizing. Therefore, it is necessary to get rid of the impurities as far as practicable. This is done by what is known as the carbonation process, which consists of adding lime to the liquor and then treating the mixture with CO_2. The carbon-dioxide gas, rising through the liquor, induces the precipitation of the lime; and the lime carries down with it most of the undesirable impurities. This treatment must be halted at the right moment lest the impurities be again released into solution. The lime in the liquor is removed with filter presses; and compressed air is used to maintain pressure on the filters and to hold the lime cake against the frames. The juice is subjected to a second carbonation, which is followed by one more filtering.

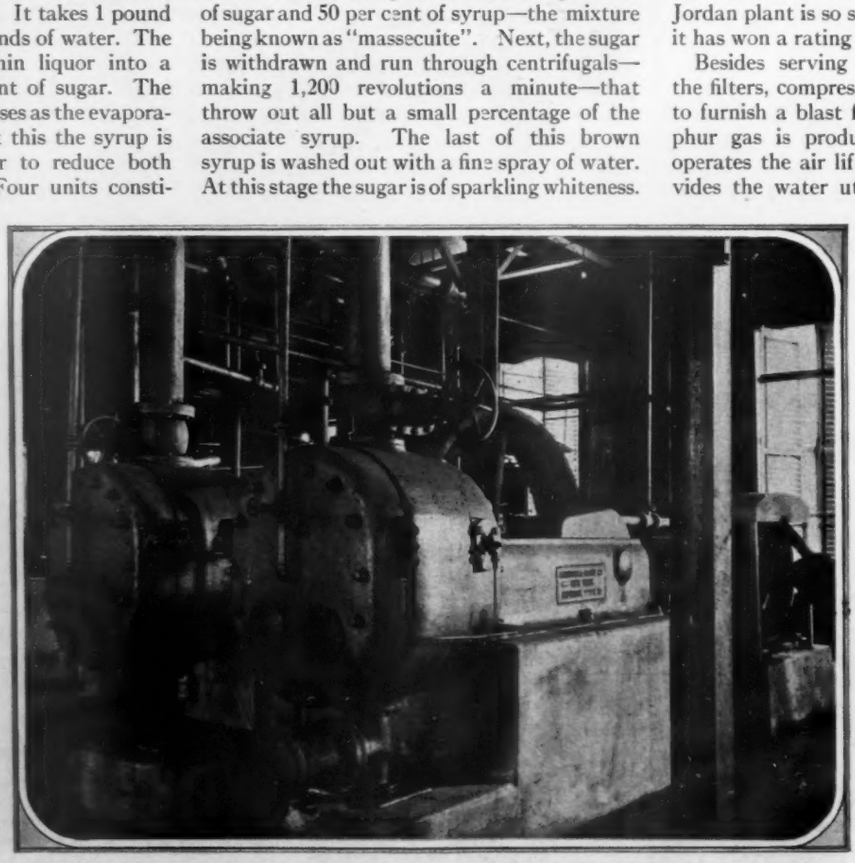


This Type 15 Ingersoll-Rand compressor furnishes air within the sugar-beet mill at West Jordan, Utah.

Further purification is effected by vigorously boiling the juice; and this causes precipitation of some of the remaining impurities—the liquor again being run through a set of filter presses. The thin liquor undergoes one more operation before evaporation—that of heating the juice with sulphur fumes. The sulphur does two things: it bleaches the liquor and reduces its viscosity. A viscous syrup will not boil readily and therefore slows up the forming of crystals.

The evaporators operate under a high vacuum—namely, at 21 inches—because of the altitude of West Jordan. It takes 1 pound of steam to evaporate 4 pounds of water. The evaporators convert the thin liquor into a syrup containing 60 per cent of sugar. The alkalinity of the syrup increases as the evaporation proceeds; and to offset this the syrup is again treated with sulphur to reduce both alkalinity and viscosity. Four units constitute an evaporator battery; and the syrup passes from one to another. After being subjected to this quadruple effect, the syrup is given a final filtering and then run through vacuum pans where the sugar crystals form because of further evaporation of the water in the syrup. Each vacuum pan holds in a liquid state enough material to produce 350 bags of sugar—a bag weighing 100 pounds. The time required to bring about this crystallization is 2½ hours. Highly skilled men are in charge of this sugar-boiling work.

Steam coils in the vacuum pans furnish the necessary heat to induce boiling. Crystals gradually form in a pan, and these small crystals act as nuclei for the growth of the sugar particles. As the density of the syrup increases, a point is reached when still other small crystals begin to form; and this tendency is checked by admitting a new charge of liquor into the vacuum pan. The process is continued until the pan contains 50 per cent of sugar and 50 per cent of syrup—the mixture being known as "massecuite". Next, the sugar is withdrawn and run through centrifugals—making 1,200 revolutions a minute—that throw out all but a small percentage of the associate syrup. The last of this brown syrup is washed out with a fine spray of water. At this stage the sugar is of sparkling whiteness.



Vacuum pumps are essential to the successful working of the vacuum pans that induce the formation of sugar crystals.

From the centrifugals, the sugar is carried by mechanical loaders to a heated, revolving drum through which currents of warm air travel. Here the damp sugar is dried and made ready to be bagged by automatic weighing and filling machines. What are known as "green syrup" and "wash syrup" are obtained in producing the final white sugar. The green syrup contains certain impurities not removed in processing, and this syrup is used in the manufacture of brown sugar. The wash syrup, on the other hand, is pure, and is returned to the vacuum pans for retreatment. The green syrup is boiled to extract the brown sugar, which is first treated with sulphur to bleach it and then put through the "white pans". The syrup made while treating the brown sugar is called molasses.

The mill at West Jordan produces during a campaign 140,000 bags of sugar. This output will vary according to the sugar content of the beet crop. The plant makes two grades of white sugar: No. 1 is of standard grain, and No. 2 is for table use and for preserving. No. 2 is really the better-appearing sugar, but foreign trade demands No. 1. The plant also turns out pulverized sugar. The pulp from the diffusion cells, when dried, makes an excellent cattle food.

At every stage the sugar-making is under complete laboratory control; and the final product is given a Government grading on the score of whiteness. The sugar from the West Jordan plant is so superior in this respect that it has won a rating of "A-plus".

Besides serving to maintain pressure on the filters, compressed air is used in the plant to furnish a blast for the stove in which sulphur gas is produced; and compressed air operates the air lift on a deep well that provides the water utilized in different departments of the mill.

The farmers are guaranteed $6 a ton for their beets—the yield per acre ordinarily ranging from 14 to 15 tons. In addition to this guarantee they receive a bonus based upon the sugar recovery above normal extraction and upon any increased price of sugar. The normal sugar content is 16 per cent. In dividing the bonus, the farmers get 48 per cent and the mill 52 per cent of it. This arrangement insures the farmer a certain profitable return upon his labors and a premium when circumstances are favorable. This encouragement has had much to do in the notable development of Utah's beet-sugar industry.

Calyx Drill Reveals Soundness Of California Dam

By GOWER WATERS

HOLLYWOOD, Calif., made world-famous by its movie activities, obtains its water from a reservoir a short distance north of that picture city. The water for this community is impounded in a valley that is blocked by an imposing dam of reinforced concrete. As a matter of fact, the dam and the associate reservoir form part of the far-flung Los Angeles water-supply system.

Months ago, after the failure of the St. Francis Dam, apprehension—mostly quite unwarranted—spread throughout the neighboring region; and steps were promptly taken at a number of places to ascertain whether or not other reinforced-concrete dams were structurally stable and resting upon foundations of ample strength. The people of Hollywood shared in this feeling of uncertainty. They realized that the failure or collapse of the Mulholland Dam would unavoidably entail an enormous loss of life and property. A panicky public usually demands more than official assurance to quiet its anxiety; and Hollywood was no exception to the rule.

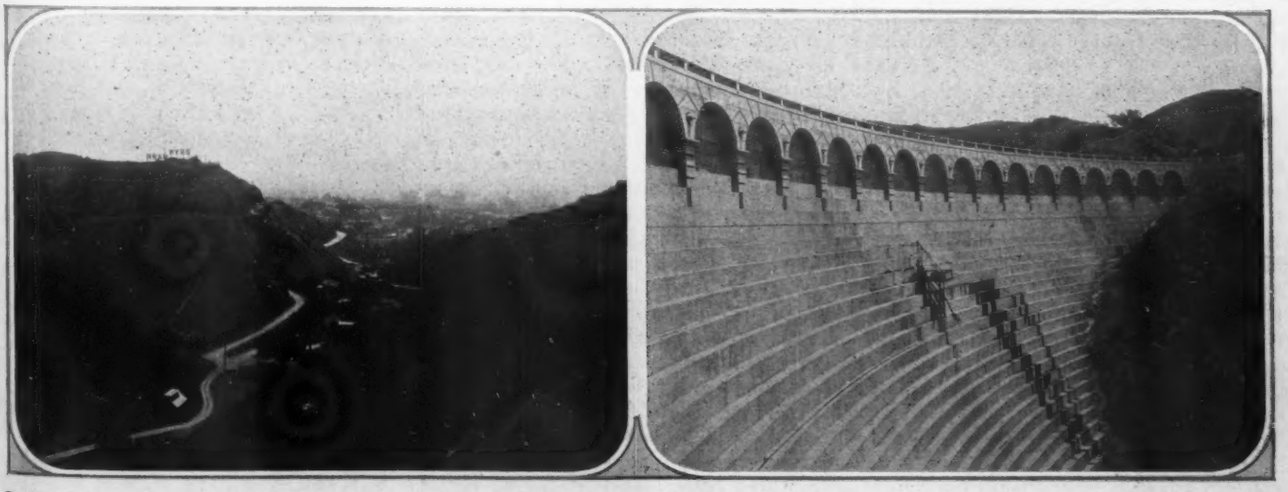
The consulting engineers identified with the construction of the dam reported it to be perfectly safe. They based their report upon continued and thorough examinations made at suitable periods; and, of course, they were intimately familiar with every structural feature having to do with the soundness and the engineering correctness of the dam. However, to make doubly sure that all was well, a series of exploratory borings were made at strategic points on the downstream face of the dam as well as where the dam is anchored to the underlying rock which sustains the structure. The object of the borings was to obtain cores that would show the condition of the reinforced concrete and the intimacy of the bond between the concrete and the supporting ledge. It was essential that each core be of considerable length, and susceptible of being recovered unshattered so that it would give an accurate idea of the physical state of the materials penetrated. These requirements could not be satisfied until a Calyx drill, with a 6½-inch tool, was brought into service.

Two of the numerous cores obtained with the Calyx drill. The right-hand core was taken from the sandstone foundation of the dam and the left-hand core from the concrete.

That drill made it possible to procure cores having a diameter of 5½ inches and an average aggregate length of about 25 feet each—that is, they were from 10 to 15 feet in the concrete while the remainder was in the bedrock. All told, substantially seventeen holes were drilled; and the drilling speed averaged 2 feet an hour. The Calyx drill, besides piercing the rock and the concrete, was able to cut its way right through the steel rods forming the reinforcement of the concrete. This is striking evidence of the abrasive action of the steel shot which actually do the cutting in the case of the Calyx drill.

The cores so obtained completely verified the assertions of the consulting engineers and, as was most desired, dissipated all doubts that the dwellers in Hollywood might have had regarding the structural soundness of the near-by dam.

The American Society for Steel Treating has recently announced that its next semi-annual meeting is to be held in Los Angeles, Calif., from January 14 to 18, inclusive, in connection with the first Western Metal Congress and Western States Metal and Machinery Exposition. The program will include daily technical sessions on the making, working, and treating of metals; and the exhibition will portray every phase of the metal industry from the raw material to the finished product. The event promises to be the biggest thing of the kind in the metal industry ever to be conducted in the West.



Left—Hollywood seen in the distance from the top of the reservoir dam. Right—Downstream face of the Mulholland Dam with Calyx drill at work making exploratory borings.

Compressed Air Magazine

—*Founded* 1896—

Devoted to the mechanical arts in general, especially to all useful applications of compressed air and to everything pneumatic.

Business and Editorial Offices:

Bowling Green Building, No. 11 Broadway, New York City
Tel. Bowling Green, 8430

Publication Office: Phillipsburg, New Jersey

TERMS OF SUBSCRIPTION

$3 a year, U. S. A., American possessions and Mexico; all other countries $3.50 a year, postage prepaid. Single copies, 35 cents. Back issues more than six months old, 75 cents each.

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EDITORIALS

SUCCINCHLORIMIDE

DON'T be dismayed by the length of the foregoing word or the difficulties encountered in training the tongue to dispose of it with facility. Succinchlorimide is a chemical compound of succinic acid and chlorine that has been perfected after considerable laboratory work which had for its aim the production of a sterilizing medium that could be put up in a handy form for the purification of water for drinking purposes. Succinchlorimide is the outcome of research on the part of army chemists; and the public was first told of it by Maj. C. B. WOOD, of the United States Army Medical School, in a paper read by him, not long ago, before a meeting of the American Institute of Chemists. The compound is likely to prove of great benefit to campers, tourists, soldiers in the field, and other persons whose activities necessitate the use of water not under sanitary control. A small tablet or two will suffice to sterilize enough water to fill a canteen.

The development of succinchlorimide is the result of protracted investigation which sought the discovery of a chemical that would not deteriorate and that would be capable of destroying certain disease-spreading germs often found in water used for drinking. Among these germs are those responsible for typhoid fever—a disease that laid more men low and cost more lives than enemy bullets during the Spanish-American War. Also, the civilian toll from the same fever is annually a heavy one among persons unwittingly drinking from polluted water supplies. This new contribution of the chemist to the public welfare should prove a veritable boon to those that must drink water at times without being able to ascertain its freedom from contamination.

SEEKING ANCIENT TREASURE WITH MODERN AIDS

EARLY in the present year, the Sacambaya Exploration Company, Ltd., dispatched from Liverpool an organization bent, if possible, upon uncovering in a nearly inaccessible part of Bolivia a hoard of gold amounting in value to something like $60,000,000. Unlike most quests for long-hidden treasure, this one is thoroughly equipped with up-to-date facilities in the form of mechanical aids of one sort or another.

Where the Khato and the Ayopaya meet to form the Sacambaya River, Jesuit missionaries reared a stronghold shortly after the Spanish conquistadores invaded the country, then a section of ancient Peru. In time, those wide-awake priests discovered and worked rich deposits of gold; and somehow they were able to keep secret from others those sources of wealth. The riches thus garnered bred in them a spirit of resolute independence; and repeatedly they refused to pay the prescribed royalty to the Spanish Crown. This attitude finally led to their expulsion from the country; but before they were forced to leave they took effectual steps to conceal their mines and to hide a large quantity of the gold that they could not carry away with them.

At the time of their deportation, one of the Sacambaya priests gave his brother—then Prefect of Callao, Peru, a verbal description of the site of the concealed hoard; and that description, subsequently reduced to writing, constituted the only documentary proof that has ever been available upon this point. Although reliable in a measure, the document has not proved a sure guide in its entirety—possibly because of the fallibility of the human mind and perhaps due in part to the haste with which the fleeing priest had to reveal his secret. Ample evidence there is that the document was based upon fact; and the present exploration company has attacked the problem with this knowledge. It has mustered to its aid mechanical facilities that will enable it not only to clear the ground of the identified site mentioned in the document but to penetrate into the depths of the earth wherever a hidden tunnel or a mine working may be uncovered.

Portable air compressors, air-driven rock drills, pneumatic paving breakers and power hoists are among the up-to-date facilities with which these modern treasure hunters are provided. Thus equipped, they should be able to accomplish in a comparatively short while what would call for a much larger organization and a far longer time if the task were essayed with pick and shovel.

Elsewhere in the present issue, we are privileged to give a first-hand account of what the exploring company has had to do in getting over very difficult country to the scene of operations, and what it has done towards making a promising start in a fascinating quest for a stake that may be worth the reputed millions or which may leave them, as well as the rest of the world, still guessing as to where those long-dead Jesuits buried their gold.

AVIATION PROGRESS MARKED BY TWO NOVEL PLANES

AERONAUTICAL development has been advanced notably by the work of Senor JUAN DE LA CIERVA, the Spanish inventor of the autogyro, and by Prof. A. A. MERRILL, of the California Institute of Technology, to whom we owe principally a so-called foolproof biplane that was recently exhibited at Los Angeles during the National Air Races.

In various particulars, the MERRILL plane is distinctly different structurally from the usual run of flying machines—these differences being discernible to the average person unfamiliar with the refinements of the art. For the present purpose, however, all that need be said is that the MERRILL plane is virtually automatic in control when leaving the ground and when alighting—to that extent minimizing the risks of disaster and lessening the demands made upon the skill of the pilot. Similarly, the machine banks automatically when circling in flight—again reducing the necessity of expertness bred of ripe experience on the part of the person handling the controls. In brief, Professor MERRILL and his associates, Dr. CLARK MILLIKAN and Dr. A. L. KLEIN, have devised a biplane that can be quickly mastered by the beginner—hastening to that measure the day when the general public will take to flying as it has to motoring.

The autogyro marks a long step forward in the direction of greater safety in alighting by making it possible to effect a landing with only a limited run after contact with the ground. This is achieved by a wind-driven horizontal propeller that exerts an arresting or braking action and, at the same time, develops a sustaining moment. In other words, the autogyro of Senor DE LA CIERVA is an adaptation of some of the features of the helicopter; and though disaster momentarily halted the activities of the Spanish inventor, it is reasonable to expect him to push steadily onward and to build upon the indisputable successes that crowned his efforts prior to that setback. What Senor DE LA CIERVA has accomplished emphasizes the inevitableness of the helicopter; and we are prompted to query: How many of the people now interested in aviation are familiar with the extremely suggestive work of the late Dr. PETER COOPER HEWITT and Prof. FRANCIS BACON CROCKER at Ampere, N. J., where they united in devising a helicopter of great promise?

SAVING BY SIMPLIFYING COMMERCIAL FORMS

PAPER work in any organization costs time and money—not to mention the placing of a heavy tax upon patience and efficiency. The general tendency is to multiply paper work and to increase the variety of the forms employed. The average executive pays little if any heed to what this means in the operating expense account of the business, the industry, or the undertaking with which he is identified. This state of affairs led the United States Department of Commerce to

organize its Division of Simplified Practice, and through the initiative of that division many substantial savings have been effected not only in the Government service but in outside organizations in different fields of commerce and industry. We shall cite but two of these to show in a general way what may be accomplished through simplification; and we quote from an announcement made by RAY M. HUDSON, assistant director, in charge of the Commercial Standards Group of the Bureau of Standards.

"An investigation, concluded by a special committee of nine department heads of the Great Northern Railway, has resulted in a $55,000 reduction in the road's expenditures for stationery. This committee, which carried on its investigation for eighteen months, examined 3,689 forms of stationery. Of this number, 379 were found to be obsolete; 651 were consolidated; and 1,980 were revised—leaving only 679 forms which were not altered. Savings were made by standardizing sizes, reducing varieties, and cheapening the quality of paper stock wherever possible. Another road, the Western Maryland Railway Company, by standardizing its stationery and printing—including ink, pens, pencils, and other office items, reduced the stationery and printing bill of the road from $110,000 to $65,000 per year."

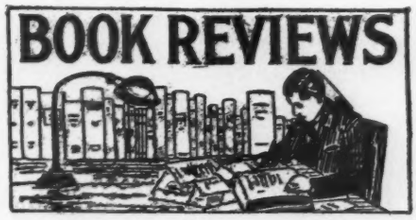
What has been done by these railroads points to what may be accomplished along similar lines by other organizations.

WASTE BY-PRODUCT YIELDS VALUABLE IRON ORE

ITALY is now supplying her iron industry with approximately 132,000 tons of pig iron annually simply through the utilization of what was heretofore considered a waste material. This is of great economic importance to the nation, as no large deposits of iron ore are known to exist in Italy.

In the manufacture of sulphuric acid from iron pyrites, Italy produces annually more than 385,000 tons of pyrite cinders in the form of a very fine powder. This could not be used in the past in the making of pig iron because of a lack of any practical method for removing certain undesirable mineral contents, such as copper, etc. These impurities are now being extracted by a patented process in a large plant recently completed on the outskirts of Venice.

We are indebted to *Commerce Reports* for the following particulars regarding the process. The pyrite cinders are first treated with sodium chloride or common salt, and then by lixiviation. The copper contained in the cinders is thus transformed into a soluble salt, which is afterwards precipitated in a metallic state. The sodium employed in the process is recovered in the form of Glauber's salts, also widely used in industry. The material is next briquetted—the briquets being heated in large ovens to bind the mass so as to facilitate handling. The product is said to be extremely porous, permeable to gases, and completely desulphurized, and constitutes an ideal mineral ore for blast furnaces.



AMERICAN CHEMISTRY, by Harrison Hale, Ph.D. An illustrated book of 255 pages, published by D. Van Nostrand Company, Inc., New York City. Price, $2.50.

WHETHER the populace recognizes it or not, the fact remains that chemistry is playing a continually increasing part in the life of the American people. In order that this state of affairs may be more widely understood, Doctor Hale has written the present book. His idea is to bring home to all of us the wonderful chemical possibilities in America and to encourage the average reader to familiarize himself through current literature with what has been achieved and what may be expected. His chapters deal with water and sewage; with food and fertilizers; with textiles and cellulose; with coal tar and dyes; with paints and varnishes; with rubber, etc., etc.

ADVENTURES IN ALASKA, by Wendell Endicott. A copiously illustrated work of 344 pages, published by Frederick A. Stokes Company, New York City. Price, $5.00.

THE more one learns of Alaska and its natural wonders, the more alluring that treasure house becomes—especially to so many of us that have not a first-hand knowledge of any sort of that vast possession of ours. Mr. Endicott has wandered far and wide in Alaska, and has seen things with the understanding of the nature lover. He has made for us a record of his travels that reads like a succession of absorbing camp-fire stories. He has done an excellent thing in bringing out the present book.

MATTHEW FONTAINE MAURY, by Charles Lee Lewis, Associate Professor United States Naval Academy. An illustrated book of 264 pages, published by The United States Naval Institute, Annapolis, Md. Price, $6.00.

MATTHEW Fontaine Maury's name should be familiar to every American; but such, unfortunately, is not the case. As has been said by the author in his opening sentence, "No other great American has ever received so many honors abroad and so little recognition at home as has the oceanographer, Matthew Fontaine Maury". Years before Maury resigned from the United States Navy to cast his lot with that of the Confederacy and to give of his best in the naval service of the South, he had won international renown through his writings that were to play so conspicuous a part in adding safeguards to the mariner. His scientific mind revealed in astronomical work and in the study of the free winds of the sky and the systematic currents of the sea. His physical geography of the sea is just as fascinating today as it was when first written by his wonderfully fluent and lucid pen.

Maury was a man of strong convictions: an energetic advocate of anything he believed in; and it was his intellectual industry and steadiness of purpose that won for him both preeminence as well as prejudice—the latter being painfully evidenced at a critical period in his naval life by certain of his professional brethren that should have been glad to honor him rather than to bring humiliation upon him. The purpose of the book is to bring within the reach of the general public a comprehensive biography of Maury—probably the completest record that has yet been written of that genius; and a reading of the work will show how much we as a people and the world at large are indebted to his labors and to his vision that foresaw many things that have since become recognized institutions for the public weal.

MINIATURE BOAT BUILDING, by Albert C. Leitch. An illustrated work of 242 pages, published by The Norman W. Henley Publishing Company, New York City. Price $3.00.

WHETHER as a source of regular income or as a form of diversion, the construction of working models of racing, sail, and power boats offers a fascinating form of occupation. With a measurable amount of skill in the handling of woodworking tools and with a natural or acquired love of precision, one can achieve all the things for which this volume is designed to serve as a comprehensive guide. The author has gone to much pains to make the details of construction plain; and if faithfully followed the results should be gratifying.

THE MODERN GASOLINE AUTOMOBILE, by Victor W. Page, M. E. A copiously illustrated volume of 1,148 pages, published by The Norman W. Henley Publishing Company, New York City. Price, $5.00.

ORIGINALLY this book appeared in a less comprehensive form in 1912. Today the book is virtually a new one from cover to cover, and represents a compendium that may properly be said to embrace the entire art as far as it is practicable to do so in a work of this kind. The importance of the subject is apparent when we bear in mind that there are in use at the present time in the United States approximately 25,000,000 motor vehicles; and engineering skill of a high order and a multiplicity of methods have been and are being employed in turning out the cars.

GEOLOGY OF PETROLEUM AND NATURAL GAS, by Ernest Raymond Lilley, Sc.D., Associate Professor of Geology at New York University. An illustrated volume of 524 pages, published by D. Van Nostrand Company, Inc., New York City. Price, $6.00.

WHY, some one will ask, has another work been written on the subject of the geology of petroleum and natural gas? Many of us are aware that much has been written and printed on the subject. Even so, knowledge is accumulating rapidly; and the mass of descriptive details today available has reached tremendous proportions and still goes on expanding. As a consequence, it is now well-nigh impossible for the individual actively engaged in practicing the profession of petroleum geology to keep up with this literature. Conscious of this, the author explains: "This book has been written to supply to such individuals and to others, whose work brings them into contact with geologic problems in the field of oil and gas, a single volume in which they may find brief statements of principles of the science and examples illustrative of the application of those principles."

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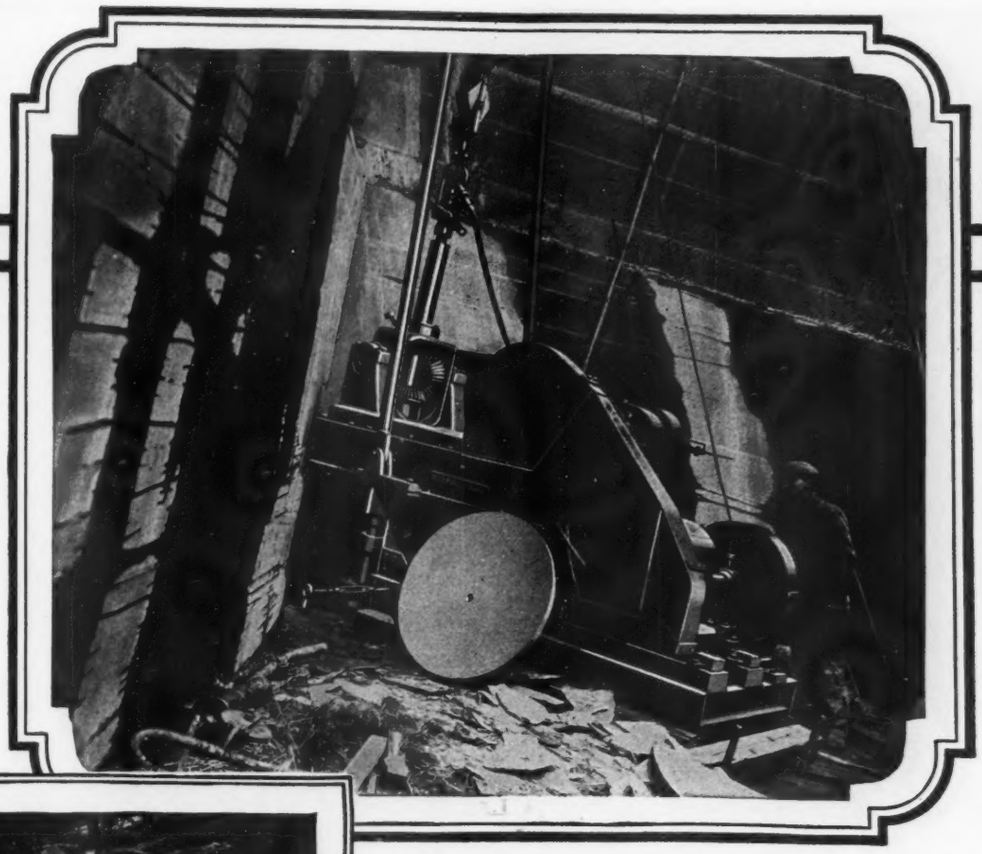

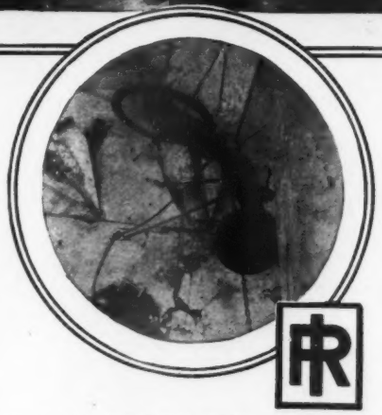

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Center: Thread-like cut made by the wire saw.
Bottom: Tension pole in the calyx drill hole. Note the pulleys for guiding the wire.

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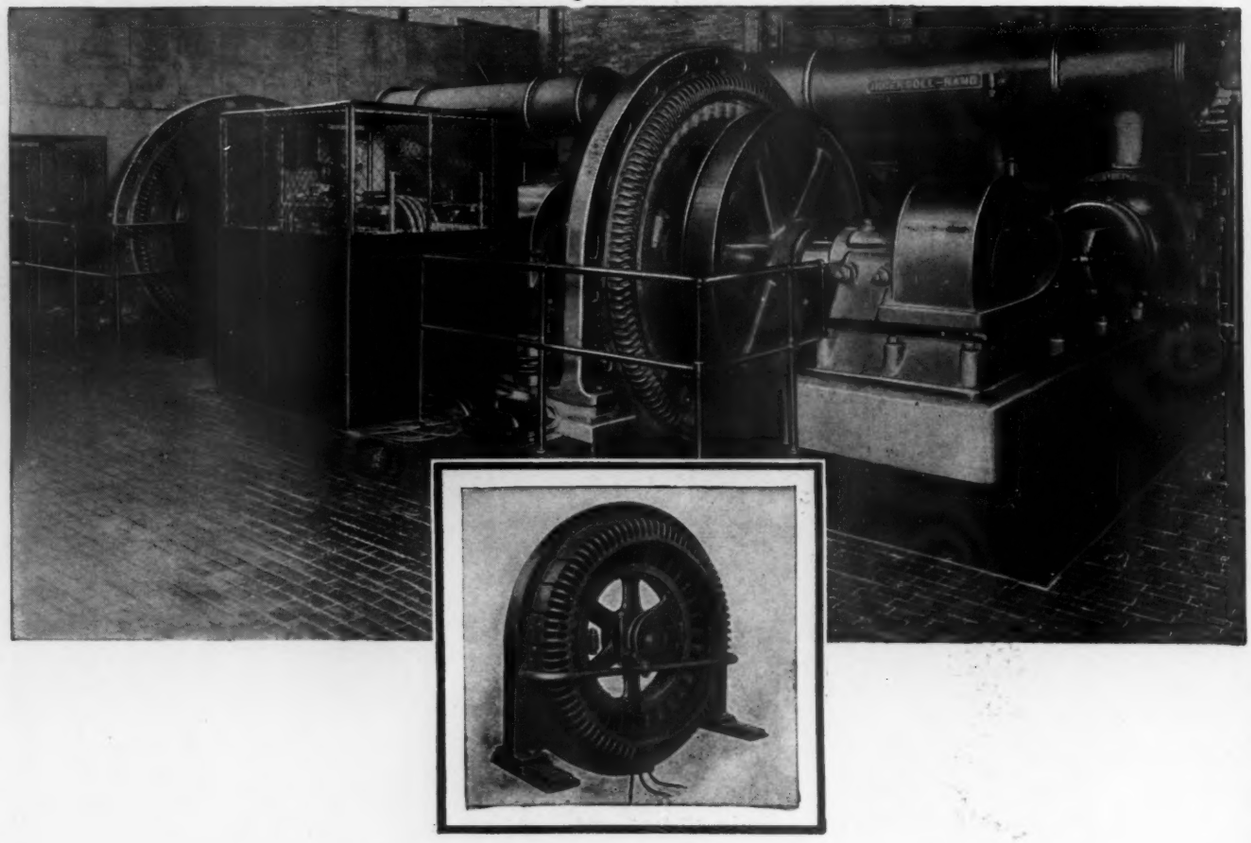

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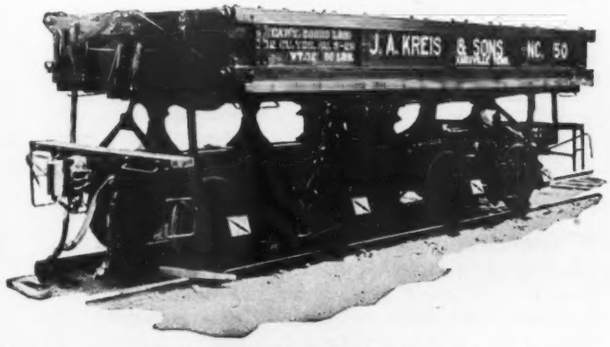

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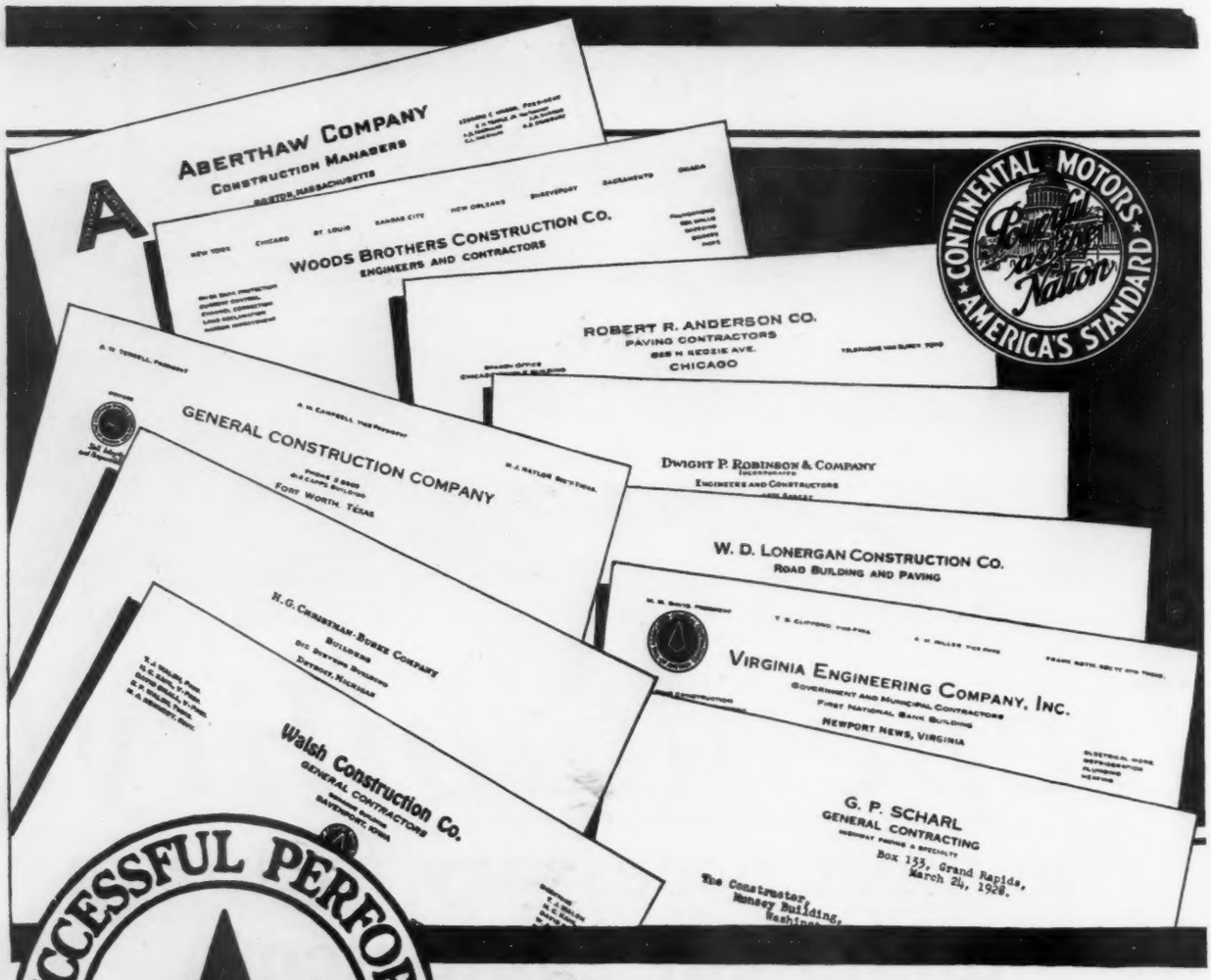

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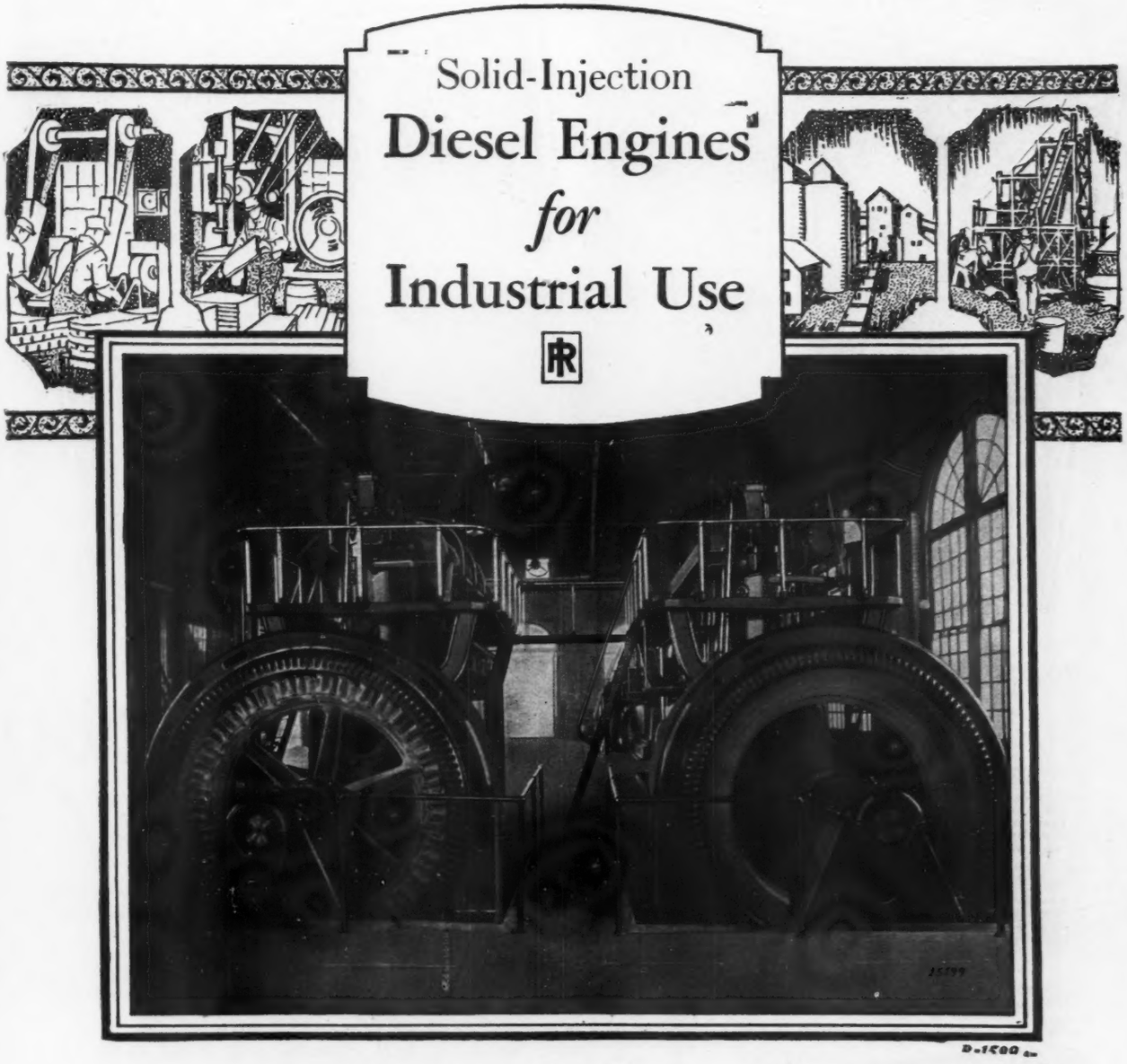

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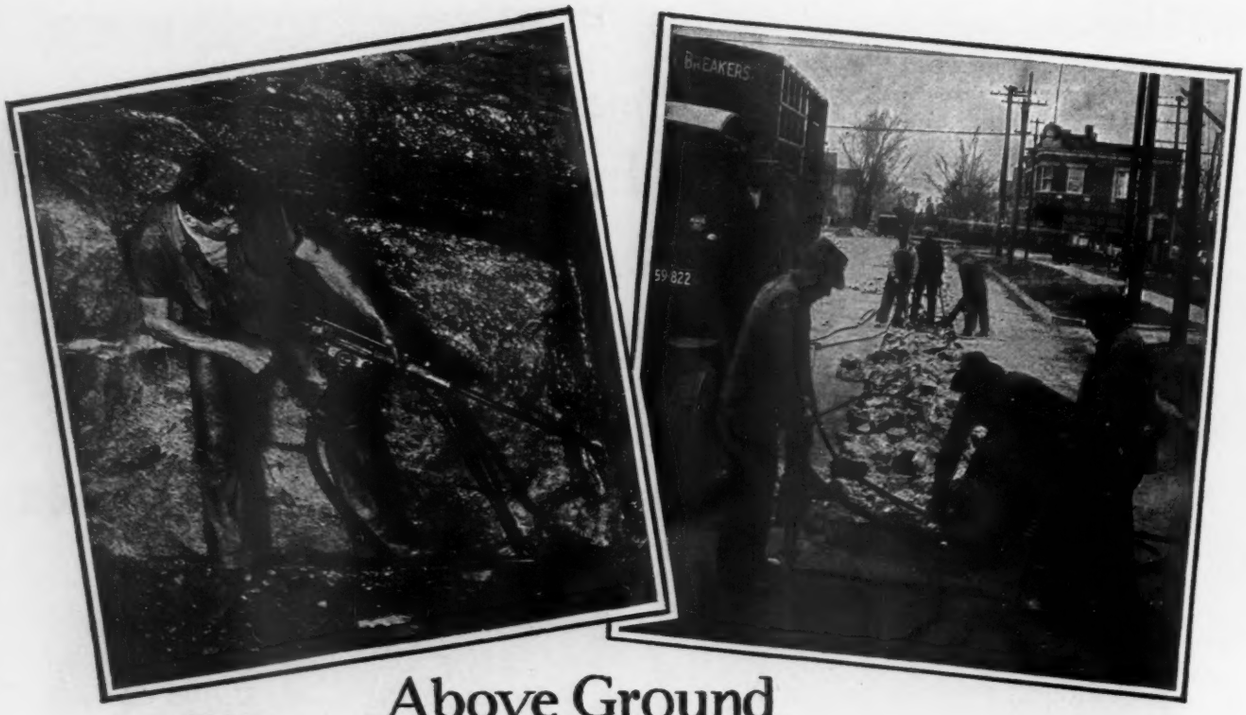

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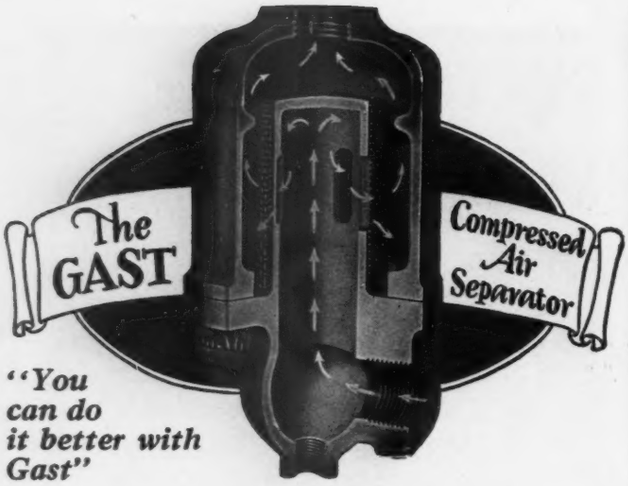

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Avoid air trouble at its source

OIL is good for pneumatic tools but will rot the air hose. Water is harmful to both.

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A Gast Separator installed in the air line will take out all the moisture and oil and will give your air tools a chance to do their work right.

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☐ Tell me more about Gast Air Separators.

Name.....

Company.....

Address.....

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Save real money by painting and sandblasting with air

Consider these savings: One man with a MULTIBLASTER can do the work of a gang of six (using hand methods) at either sandblasting or painting. The man with the MULTIBLASTER does a better, more lasting job. Waste of materials is greatly lessened.

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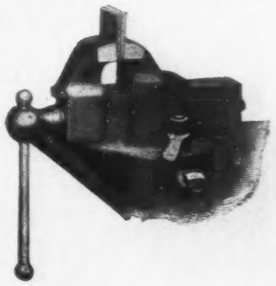

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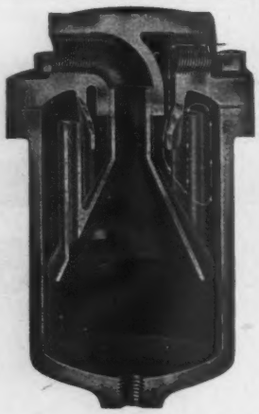

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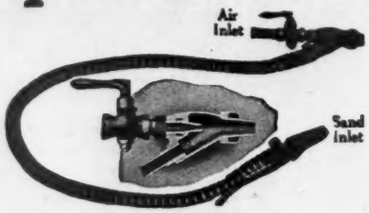

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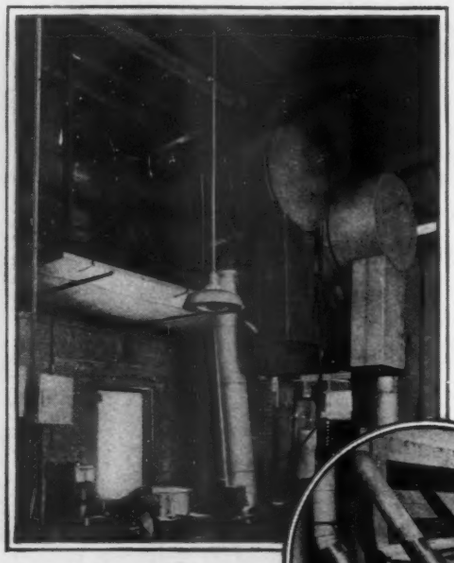

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Noise Anti-toxin

INDUSTRIAL workers often are in need of a noise anti-toxin.

Noise is tearing their nerves to pieces.

And for many noises—those involving air, gas or steam—the Maxim Silencer is the anti-toxin.

Exhausts from engines, intakes to and discharges from compressors and blowers, safety valve discharges—all yield and become quiet.

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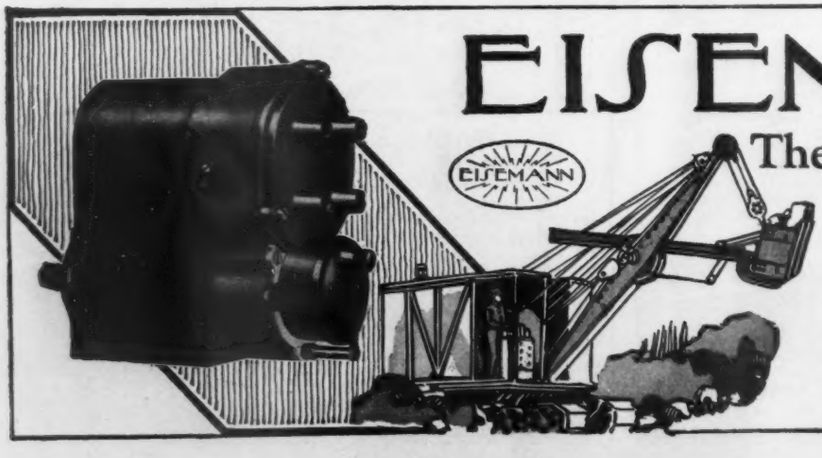

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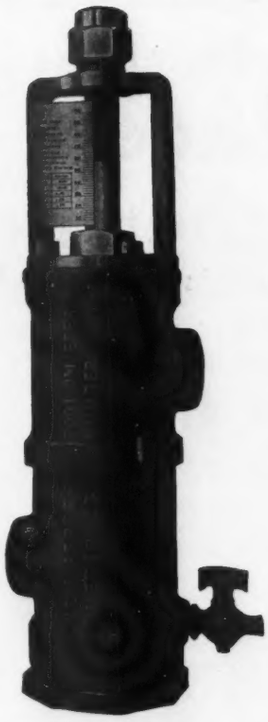

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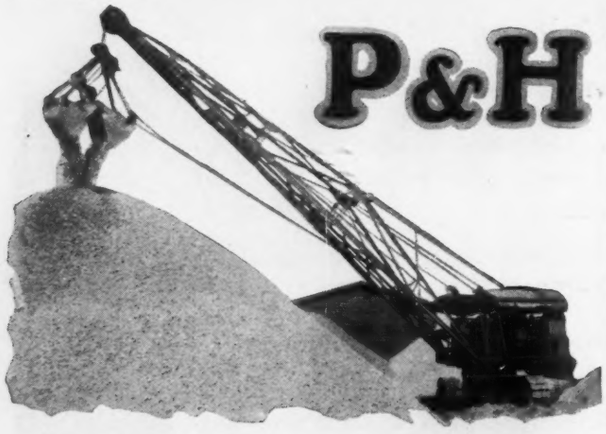

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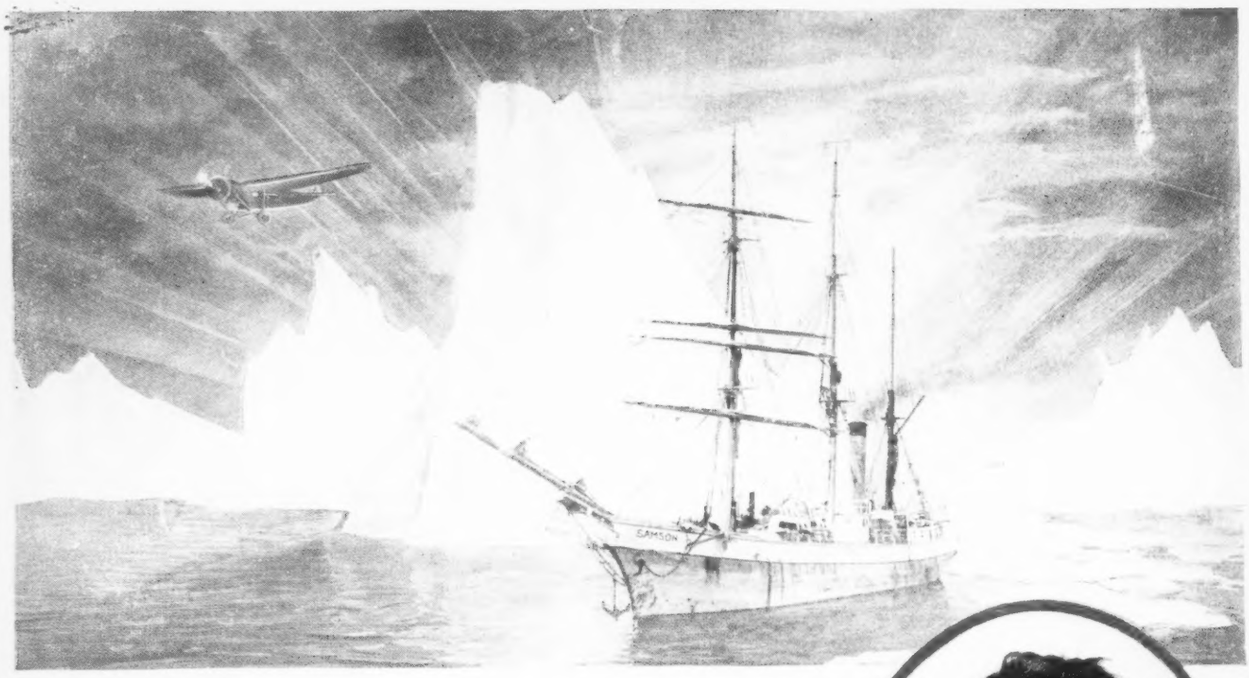

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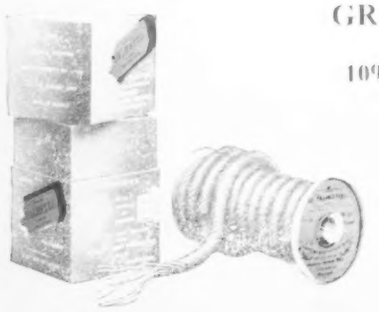

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